COSMIC CONSIDERATIONS IN MEGALITHIC ARCHITECTURE

(AN INVESTIGATION INTO POSSIBLE ASTRONOMICAL INTENT IN THE DESIGN AND LAYOUT OF MEGALITHIC MONUMENTS OF THE INDIAN SUBCONTINENT WITH A VIEW TO UNDERSTANDING MEGALITHIC KNOWLEDGE SYSTEMS)

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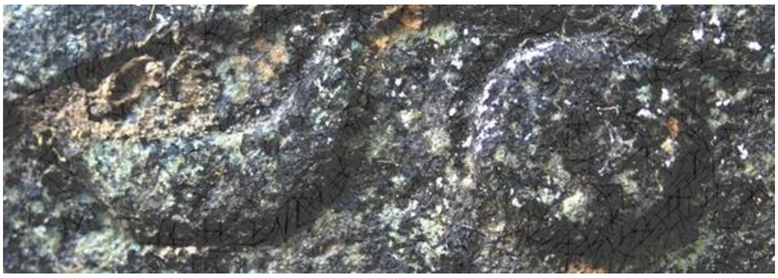

Dedication

To my father

Shri. Manakkeparambil Madhava Menon

How I wish you were alive to see this task completed...

And

my mentor and idol

Shri. Syed Abdulla Hussain

With gratitude for all the affection and inspiration...

Hero stones were conceived to honour men like these...

CERTIFICATE

This is to certify that the thesis titled ***"Cosmic Considerations in Megalithic Architecture: An Investigation into Possible Astronomical Intent in the Design and Layout of Megalithic Monuments with a View to Understanding Megalithic Knowledge Systems"*** is a bonafide research work carried out by **Srikumar M. Menon** under our guidance for the degree of Doctor of Philosophy. This is an original piece of work and has not been submitted for any other degree of any other University.

(Mayank N. Vahia)	**(Sudhakara G.)**
Guide	**Co-guide**

Manipal

Date:

Abstract: This thesis examines the megalithic monuments of peninsular India – commonly accepted as belonging to the south Indian Iron Age (roughly 1200BC – 500BC), for intentional alignments of the whole monuments or design components to points of astronomical interest on the local horizon. This is in order to understand the level of intellectual development and status of knowledge systems extant among the cultures that authored these monuments, which is not revealed by conventional archaeological examination of the material culture of these peoples. The methodology employed was to arrive at a shortlist of megalithic monuments/sites to be visited from extensive survey of the available literature and conduct reconnaissance surveys of these. In all 33 sites (20 in Karnataka, 8 in Kerala, 3 in Vidarbha region of Maharashtra and 1 in Tamil Nadu) were visited. Of these, orientation surveys were carried out at 12 sites, partial surveys at 4 sites and complete surveys at another 4 sites. The sepulchral/memorial megaliths were found to have different orientational practices in different regions. We have recorded sites with no preferred orientation, exclusively south-facing monuments and others that showed a preference for east/west facing orientations. We have proposed, based on stylistic chronology of the monuments, that the earliest megalithic types had no preferred orientations to cardinal directions or were exclusively north-south oriented. The later, architecturally more developed monuments preferred east-west orientations. However, it is the study of the non-sepulchral megalith type called menhirs/alignments (or avenues) that yielded the main result of this investigation. We have found that there is a unique megalithic "avenue" type monument in southern coastal Karnataka consisting of several menhirs (either quarried slabs or natural boulders of elongated cross-sections) that are erected on end in specific patterns that are aligned to the extreme rising/setting points of the Sun and Moon on the local horizon. This megalithic type, that we have named the "Nilaskal type" after the extensive type site south of Hosanagara, is represented by 5 sites – Nilaskal, Byse, Heragal, Mumbaru and Aaraga Gate. We have also studied Nagbhid – a similar site in Vidarbha, which extends the geographical range of this type. Two hitherto unrecorded sites were discovered during this study.

Keywords: Archaeoastronomy, megaliths, menhir, stone alignment, solstices, lunistices, Nilaskal, Byse, Heragal, Mumbaru, Aaraga Gate

प्रज्ञानं ब्रह्म

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INSPIRED BY LIFE

DECLARATION

I hereby declare that the work presented in this thesis titled ***"Cosmic Considerations in Megalithic Architecture: An Investigation into Possible Astronomical Intent in the Design and Layout of Megalithic Monuments of the Indian Subcontinent with a View to Understanding Megalithic Knowledge Systems"*** *has been carried out by me under the supervision of* ***Prof. Mayank N. Vahia****, Department of Astronomy and Astrophysics,Tata Institute of Fundamental Research, Mumbai and* ***Prof. Sudhakara G.****, Department of Mathematics, Manipal Institute of Technology, Manipal University, Manipal, and that this thesis has not been submitted for any degree or diploma of any other university earlier. The particulars given in this thesis are true to the best of my knowledge and belief.*

Manipal **Srikumar M. Menon**

July 2012

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Srikumar M. Menon

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Table of Contents

Acknowledgements iv

Executive Summary viii

Table of Contents xii

List of Figures xvi

List of Tables xxii

1 Chapter 1: An Introduction to Megaliths…………………………………...1-33
- 1.1 World prehistory in general 1
  - 1.1.1 The 3-Age system 2
  - 1.1.2 A rough chronology of world prehistory 5
  - 1.1.3 Architecture in the prehistoric world 7
  - 1.1.4 Stonehenge – a unique prehistoric monument 10
- 1.2 Indian Prehistory – a brief overview 12
  - 1.2.1 The Phases of Prehistoric Human Occupation in India 13
  - 1.2.2 Architecture in prehistoric India 17
- 1.3 The megaliths of the Indian subcontinent 22
  - 1.3.1 The megaliths of south India 23
  - 1.3.2 The distribution of megaliths in India 25
  - 1.3.3 Chronology of the Indian megaliths 28
  - 1.3.4 Settlement sites of the megalithic age 29
  - 1.3.5 Pottery 29
  - 1.3.6 Socio-economic basis for megalithic society 30
  - 1.3.7 The south Indian megalithic complex– outstanding issues 32

2 Chapter 2: Origins of astronomy……………………………………………(34-60)
- 2.1 The sky as a cultural resource 34
- 2.2 Naked-eye astronomy 36
  - 2.2.1 The celestial sphere 37
  - 2.2.2 The Solar cycle 39
  - 2.2.3 The Lunar cycle 40
  - 2.2.4 Stellar observations 42
- 2.3 Origins of astronomy – the world perspective 43
  - 2.3.1 Astronomy in Babylon 45
  - 2.3.2 Egyptian astronomy 45
  - 2.3.3 Greek astronomy 46
  - 2.3.4 Prehistoric astronomy in the world 46
- 2.4 Ancient Indian astronomy 49

2.4.1 Milestones in early Indian astronomy 49
2.4.2 Indian prehistoric astronomy 50
2.4.3 The issues of orienting markers 52

3 Chapter 3: Megaliths and Astronomy……………………………………(61-85)
3.1 Indian megaliths – classification and architecture 61
3.1.1 Sepulchral Megalithic Monuments 63
3.1.2 Non-sepulchral Megalithic Monuments 66
3.1.3 Distribution of the various megalithic types in the Indian subcontinent 67
3.1.4 Basic tenets of megalithic architecture 71
3.1.5 Megaliths and later architecture 79
3.2 Megaliths as direction and location markers 80
3.2.1 Megaliths as possible calendar devices 82
3.2.2 On what constitutes a reliable sightline 82

4 Chapter 4: Our Approach…………………………………………….(86-120)
4.1 Background – megalithic knowledge systems and belief systems 86
4.2 Aims and objectives of the current study 88
4.3 Summary of aims and objectives 89
4.3.1 Aim 89
4.3.2 Objectives 89
4.4 Methodology 90
4.4.1 Astronomy in megaliths 94
4.4.2 Astronomical sightlines at avenue sites 95
4.4.3 Preferred orientation patterns at sepulchral sites 95
4.4.4 Stylistic evaluation and possible chronology as deduced from the refinement of working, components, form and design 96
4.5 Study areas 96
4.5.1 The sites of north Karnataka 97
4.5.2 The sites of south coastal Karnataka 104
4.5.3 The site at Chikel Chetti 107
4.5.4 The Kerala sites 107
4.5.5 The sites of Vidarbha 109
4.5.6 The site at Burzahoma, Kashmir Valley 111
4.5.7 The site at Vadakkipatti, Tamil Nadu 111
4.6 Study Methods 111
4.6.1 Preliminary studies and pre-reconnaissance planning 111
4.6.2 Reconnaissance visits and surveys 111
4.6.3 Orientation survey methods 112

5 Chapter 5: Data and analysis……………………………………………..(121-176)
5.1 Brahmagiri 121
5.2 Marayoor 123
5.3 Burzahoma 124
5.4 Chikel Chetti 127
5.5 Hire Benakal 130
5.6 Onake Kindi 134
5.7 Nilaskal 136
5.8 Byse 139
5.9 Heragal 143
5.10 Mumbaru 145
5.11 Eyyal 146
5.12 Kudakkallu Parambu 146
5.13 Chowwannur 146
5.14 Kakkad 146
5.15 Kattankampal 147
5.16 Ariyannoor 148
5.17 Kandanasserry 148
5.18 Aihole 150
5.19 Bachinagudda 153
5.20 Hanamsagar 154
5.21 Kyaddigeri 156
5.22 Chik Benakal 157
5.23 Vibhutihalli 159
5.24 Bheemarayanagudi 161
5.25 Gudde Maradi 162
5.26 Konaje Kallu 162
5.27 Kakkunje 164
5.28 Rajan Koluru 165
5.29 Aaraga Gate 170
5.30 Vadakkipatti 171
5.31 Junapani 173
5.32 Nagbhid 173
5.33 Champa 175

6 Chapter 6: Analysis, discussion of findings and conclusions………..(177-216)
6.1 Analysis 177
6.1.1 Points of celestial significance on the horizon 177
6.1.2 Analysis of the sepulchral and commemorative megalith types 179
6.1.3 Analysis of the avenue/alignment sites 181
6.2 Results and discussion 202

6.2.1 The sepulchral/commemorative megaliths 202
6.2.2 The avenue/alignment sites 204
6.3 Conclusions 209
6.3.1 The sepulchral architecture of the megalithic times 209
6.3.2 Stone alignments and astronomy 210
6.4 Perspectives for future research 211
6.4.1 Inclinations of the stones at Nilaskal 212
6.4.2 Examination of the sepulchral megaliths at Byse 212
6.4.3 Identification of source quarries 213
6.4.4 Habitation sites for Nilaskal and Byse 213
6.4.5 Development of adequate statistical methods for testing ancient astronomical sites 213
6.4.6 Study of similar megalithic types in differing contexts 214
6.4.7 The relationship of megaliths with later religious traditions and architecture 215

7 References……………………………………………………………….(217-223)

8 Bibliography…………………………………………………………..(224-236)

List of Figures

Chapter 1		
Figure 1.1	A rough stone tool identified as "concave scraper" from the Middle Stone Age found at Sannati, Karnataka, India	3
1.2	A plan of the houses at Skara Brae (Castleden 1987)	9
1.3	A aerial view of Stonehenge	11
1.4	A view of one of the "pit dwellings" of Burzahom	18
1.5	A view of the ashmound at Kudatini (Boivin et al)	20
1.6	The severely disturbed megalithic site of Chik Benakal	21
1.7	A "rock-shelter chamber" megalith at Hire Benakal	24
1.8	Dolmens of the central group at Hire Benakal	25
1.9	A view of the megaliths at the Neolithic village-site of Burzahom	26
1.10	A menhir at Nilaskal, Karnataka	27
1.11	A rock art panel at Onake Kindi, near Hire Benakal, Karnataka	33
Chapter 2		
2.1	The celestial sphere	37
2.2	Showing the celestial equator, ecliptic and the celestial co-ordinate systems	38
2.3	Showing diurnal path of the Sun for the equinoxes and solstices for a location N of the equator	40
2.4	The phases of the Moon	41
2.5	Showing markers to points on horizon for the solar and lunar celestial events	42
2.6	Precession of the Earth’s axis	43
2.7	Showing the precession of the equinoxes	43
2.8	The Rosetta Stone which helped the deciphering of two ancient scripts that later enabled the recognition of Egyptian astronomical observing records	44
2.9	Stonehenge - astronomical observatory or ritual monument?	47
2.10	A portion of the stone alignment at Hanamsagar, viewed from the west	51
2.11	Simulation studies for one part of the structure claimes as a Harappan observatory (Vahia and Menon 2011)	52
2.12	Change in the Sunrise point over 1 year from Winter Solstice to Summer Solstice	54
2.13	Showing the angular spread of the variation of sunrise point along the horizon. For simplicity, the observer is assumed to be at the equator	55
2.14	Showing division of the variation of sunrise point along the horizon into equal “months”	56
2.15	Marking of stone patterns in an observatory	57
2.16	Stone markings in a circularly made observatory. Additional stones can be used to mark north and south directions also	58
2.17	Square structure observatory	59

2.18	Possible structure of markers for a solar observatory structure	59
Chapter 3		
3.1	Classification scheme for sepulchral and non-sepulchral monuments in India (Moorti 1994, 2008)	62
3.2	Plan and section of Megalith II at Brahmagiri (Wheeler 1948)	63
3.3	A view of an excavated chamber burial with boulder circle and passage (Wheeler 1948)	64
3.4	Cutaway view of a museum exhibit of an urn burial capped by a slab (S. A. Museum, Thrissur)	64
3.5	Plan and Section of Urn Burial at Porkalam (Leshnik 1972)	65
3.6	Plan and Section of Rock-cut Cave Burial at Kandanasserry (Leshnik 1972)	65
3.7	Plan and Section of Menhir at Maski (Thapar 1954)	66
3.8	View of an avenue at Hanamsagar	66
3.9	Showing the distribution of megalithic sites in India (Brubaker 2001)	67
3.10	Showing the distribution of megalithic sites in peninsular India (Brubaker 2001)	68
3.11	Showing the distribution of stone circle megaliths in peninsular India (Brubaker 2001)	69
3.12	Showing the distribution of rock-cut cave burial megaliths in peninsular India (Brubaker 2001)	70
3.13	Showing the distribution of alignment/avenue sites in peninsular India (Brubaker 2001)	71
3.14	Line drawing of rock art at Onake Kindi near Hire Benkal (Moorti 1994)	72
3.15	Showing stages of development of a cairn circle over a pit burial	73-74
3.16	Showing stages of development of a port-holed dolmen	74-75
3.17	Showing one of the dolmens of Meguti Hill, Aihole	76
3.18	Showing dolmens at Hire Benakal	76
3.19	Hire Benakal – Rock-shelter Chamber	77
3.20	Hire Benakal – Irregular Polygonal Chamber	77
3.21	Hire Benakal – Transepted Cist	77
3.22	Hire Benakal – Dolmenoid Cist	78
3.23	Hire Benakal – Port-holed Dolmen	78
3.24	The standing stones of Callanish - a possible calendar device?	81
3.25	An alignment of two standing stones	84
3.26	Showing a sightline from this investigation wherein opposing edges of two menhirs frame winter solstice sunset (Menon and Vahia 2010a)	85
Chapter 4		
4.1	Methodology adopted for this study	90
4.2	Map showing location of Brahmagiri (Wheeler 1948)	98
4.3	Showing a satellite picture of the location of the megalithic site of Hire Benakal and the rock art site of Chitra Gund	99
4.4	Aihole and Kyaddigeri (Sundara 1975)	101

4.5	Showing location of Hanamsagar with respect to Hire Benakal and Onake Kindi	102
4.6	Showing location of Vibhutihalli	103
4.7	Showing the location of menhir site at Bheemarayanagudi	103
4.8	Showing the location of Nilaskal, Byse, Hergal, Mumbaru and Aaraga Gate	105
4.9	Showing location of the megalithic site near Konaje Kallu	106
4.10	Showing the location of the various megalithic sites at Thrissur	108
4.11	Showing the layout of menhirs at Nagbhid	110
4.12	Showing the megalithic site at Burzahoma	110
4.13	Showing diurnal circles of celestial bodies for (a) low latitudes and (b) high latitudes (Aveni 1981)	113
4.14	Measuring the orientation of a dolmen	114
4.15	Showing the measurement of the orientation of rock-cut tombs	115
4.16	Showing the measurement of the orientation of the joints of clinostats in a kudakkals	116
4.17	Showing the menhirs of Vibhutihalli – orientation measurement is not possible for individual stones	117
4.18	Showing the placement of rods for measurement of orientation of a menhir at Nilaskal	117
4.19	Showing recording of the azimuth of a single menhir at Nilaskal	118
4.20	Showing the measurement of alignments at Hanamsagar	119
4.21	Showing the measurement of azimuth of a sightline at Nilaskal	119
4.22	Showing the correction for obtaining true azimuth from magnetic azimuth given by the magnetic compass	120
Chapter 5		
5.1	Showing the spread of the megalithic sites of Wheeler 1948 (top) as seen from the hill during the visit for this study	121
5.2	Showing displaced stones of boulder circles near cists at Brahmagiri	122
5.3	Showing an apparently undisturbed megalith at Brahmagiri	122
5.4	Showing one of the dolmens on the hill near the Kovilkadavu School	123
5.5	Showing the Paisnagar dolmen	123
5.6	Showing a Marayoor dolmen with a U-shaped port-hole (Photo: Sridevi Changali)	124
5.7	Showing the layout of the various structures at Burzahoma	125
5.8	A view of the menhirs at Burzahoma from the north-west	125
5.9	Cupmarks on one of the fallen menhirs of Burzahoma	126
5.10	A mound to the south-east of the menhirs at Burzahoma	126
5.11	Site plan showing layout of megaliths at Chikel Chetti, Bandipur	128
5.12	Showing one of the exposed cists at Chikel Chetti	129
5.13	A view of the largest cairn at Chikel Chetti	129
5.14	Showing the extent of the megaliths of the Western and Central groups at Hire Benakal; the Eastern group is off the lower right	131

	corner of the image	
5.15	Showing a typical Irregular Polygonal Chamber at Hire Benakal	133
5.16	Showing a well-preserved dolmenoid cist at Hire Benakal	133
5.17	Showing the most elaborate panel of rock art at Onake Kindi	134
5.18	Showing a rock shelter at Onake Kindi in the southern portion where Panel 4 is found	134
5.19	Another panel (4) of rock art in the south at Onake Kindi	135
5.20	A panel of rock art to the east of the entry to Onake Kindi	135
5.21	Showing the megalithic site at Nilaskal	136
5.22	The second-largest surviving menhir at Nilaskal	137
5.23	Showing the broken stump of a menhir at Nilaskal	138
5.24	The largest menhir at Byse	140
5.25	One of the prominent menhirs at Byse - an undressed boulder	141
5.26	A quarried slab that acts as a menhir at Byse	141
5.27	A layout of the menhirs at Byse	142
5.28	A general view of the megalithic site at Heragal	143
5.29	Showing typical menhir cross-section at Heragal	144
5.30	One of the tallest menhirs under worship at Heragal	144
5.31	Showing a typical menhir orientation at Heragal	144
5.32	A general view of the site at Mumbaru	145
5.33	The largest standing menhir under worship in a shrine at Mumbaru	145
5.34	Showing typical menhir cross-section at Mumbaru	146
5.35	The megaliths at Kudakkallu Parambu	147
5.36	The rock-cut burial cave at Chowwannur	147
5.37	An interior view of the rock-cut burial cave at Kakkad, looking towards the entry	147
5.38	A view of the four-chambered rock-cut burial cave at Kattankampal	148
5.39	A view of the Ariyannoor Umbrellas	148
5.40	A view of the rock-cut burial cave at Kandanasserry	149
5.41	An IPC at Meguti Hill, Aihole (Meguti Temple in the background)	150
5.42	A dolmen with a U-shaped porthole and a passage	151
5.43	A dolmen without porthole at Aihole	151
5.44	The port-holed chamber tomb at Bachinagudda	153
5.45	A view of the alignment at Hanamsagar from a hill in the south-west	154
5.46	Showing collection of alignment data at a point within the arrangement of stones	155
5.47	The winter sun descends towards the rock pillars which held the golden cradle of local legend at Hanamsagar	155
5.48	Evidence for a recent removal of a megalith at Kyaddigeri (Meguti hill and temple in background)	157
5.49	Signs of fresh quarrying very close to the Jaina Cave on Meguti Hill	157

5.50	One of the dolmenoid cists at Chik Benakal	158
5.51	A possible rock-shelter chamber at Chik Benakal	158
5.52	A freshly looted megalith at Chik Benakal in January 2008	158
5.53	A part of the alignment at Vibhutihalli pointing to the sunset on 31 December 200	160
5.54	A part of the alignment at Vibhutihalli pointing to the rising sun on 01 January 2009	160
5.55	The survey map of the stones of Vibhutihalli; north is towards top	161
5.56	The fallen dressed menhir at B'gudi	161
5.57	Four of the boulders at B'gudi	162
5.58	A granite crushing unit near the site of Gudde Maradi	162
5.59	The intact lower dolmen at Konaje Kallu	163
5.60	The passage and polished porthole of the dolmen on the summit at Konaje Kallu	163
5.61	The dolmen at Kakkunje	164
5.62	Detail of the western orthostat of the dolmen showing attempts to shape the slab to match the curvature of the eastern orthostat	165
5.63	Signs of quarrying nearby at Kakkunje	165
5.64	A panoramic view of the western group at Rajan Koluru	166
5.65	A dolmen of the western group at Rajan Koluru showing a crudely fashioned porthole in the southern slab	166
5.66	A dolmen of the western group at Rajan Koluru showing shaping of side orthostats	167
5.67	Showing a port-holed dolmen of the eastern group at Rajan Koluru	167
5.68	The largest menhir at Aaraga Gate	171
5.69	Showing the orientation of a menhir at Aaraga Gate	171
5.70	A surface find of pottery at Vadakkipatti	172
5.71	A laterite boulder circle at Vadakkipatti	172
5.72	A laterite boulder shaped to the arc of the boulder circle at Vadakkipatti	172
5.73	A large boulder circle at Junapani	173
5.74	Three of the menhirs at Nagbhid	174
5.75	Three menhirs of Nagbhid seen from a tall construction in the east	174
5.76	One of the cairn circles at Champa	176
5.77	A "mini-cairn burial" at Champa	177
Chapter 6		
6.1	Showing the 18.6 year-long lunar cycle of major and minor standstills	178
6.2	Showing the alignment at Vibhutihalli with N-S, E-W and 45° lines superimposed	182
6.3	Showing the orientation of the standing menhirs of Byse	183
6.4	A view of the clearing at Byse and the horizon towards the north	184
6.5	Showing stone 8 and its fallen part	185

6.6	The sight-lines to the solstice sunrises and sunsets (N is to the left)	186
6.7	The sight-lines to the major standstill moonrises and moonsets (N is to the top)	189
6.8	The sight-lines to the minor standstill moonrises and moonsets (N is to the top)	189
6.9	Showing all observed alignments at Byse	191
6.10	Showing the distribution between pairs of stones at Byse	192
6.11	Looking westwards from near the road showing the artificial horizon created towards the west	194
6.12	Sample entry from a photographic database of all the menhirs of Nilaskal - stones are photographed from the east, south and west (Stone no. from old survey, new survey no. 74)	195
6.13	Showing menhirs 13 and 14 which were probably part of one stone originally	196
6.14	Showing validation of the sightline shown in Figure 26, Chapter 3	199
6.15	Sightline between stones 69 and 18 framing the setting sun at winter solstice	200
6.16	Sightline between stones 68 and 28-29 framing the setting sun close to winter solstice	200
6.17	Showing the orientation of individual menhirs at Nilaskal	201
6.18	Showing porthole styles from Rajan Koluru, Aihole and HireBenakal with th epolished porthole of Konaje Kallu in the centre	203
6.19	A finely worked laterite bench at the rock-cut cave at Kakkad	204
6.20	Looking east from menhir 68 at Nilaskal, one can see two other menhirs through a notch	207
6.21	Looking westwards from the same menhir, one sees another through the notch; note the raised horizon too	207
6.22	The setting sun near winter solstice as seen from the same point as in Figure 21	207
6.23	One of the Virakals in the south at the Byse site	209
6.24	The disturbed cairn (in the foreground) east of the menhir worshipped as *Rana* at Byse	210
6.25	What role did the Sun play in the cosmology of the builders of the megaliths at Nilaskal?	211
6.26	Showing a few of the prominent leaning stones at Nilaskal	212
6.27	The quarried area in the south at Byse	213
6.28	A double-row of cupmarks excised in a boulder of a boulder circle at Junapani	214
6.29	An almost intact IPC at Hire Benakal has the appearance of a mini-stupa	215
6.30	One of the small shrines at Pattadakal is reminiscent of the dolmen in its execution	216

List of Tables

Chapter 1		
Table 1.1	Showing the cultures of the Palaeolithic in relation to the periods of Glaciation	3
1.2	Chronology of the Neolithic Revolution (from Habib 2001)	7
1.3	Summary of the south Indian prehistoric from the Neolithic (3 Bauer, Johansen and Bauer 2007)	17
Chapter 3		
3.1	Classification of structures for deliberate astronomical orientation (Ruggles 1991, p. 70)	83
Chapter 4		
4.1	List of the megalithic sites visited (not including 5 sites mentioned above)	91
Chapter 5		
5.1	Summary of orientations of exposed cists at Chikel Chetti, Bandipur, Karnataka (Corrected for magnetic declination for Chikel Chetti on date of survey = 2^o 2'W changing by 0^o 0'/year)	130
5.2	Showing the summary of orientation data for randomly selected megaliths of Hire Benakal (Corrected for magnetic declination for Hire Benakal on date of survey = 1^o 29'W changing by 0^o 0'/year)	132
5.3	Summary of the orientation data for the largest menhirs of Nilaskal (Corrected for magnetic declination for Nilaskal on date of survey = 1^o 41'W changing by 0^o 0'/year)	138
5.4	Summary of the orientation and size data for the largest menhirs of Byse (Corrected for magnetic declination for Byse on date of survey = 1^o 40'W changing by 0^o 0'/year)	142
5.5	Summary of the orientation and other data for the megalithic monuments of Thrissur (Corrected for magnetic declination for Byse on date of survey = 2^o 12'W changing by 0^o 0'/year)	149
5.6	Summary of the orientation and other data for the megalithic monuments at Meguti Hill, Aihole (Corrected for magnetic declination for Aihole on date of survey = 1^o 20'W changing by 0^o 0'/year)	152
5.7	Summary of the alignment data for the megalithic monument at Hanamsagar (Corrected for magnetic declination for Hanamsagar on date of survey = 1^o 18'W changing by 0^o 0'/year)	156
5.8	Summary of the orientation and other data for the dolmenoid cists at Chik Benakal (Corrected for magnetic declination for Chik Benakal on date of survey = 1^o 26'W changing by 0^o 0'/year)	159
5.9	Summary of the orientation and other data for the dolmens at Rajan Koluru (Corrected for magnetic declination for Rajan	167

	Koluru on date of survey = 1^o 9'W changing by 0^o 1'/year)	
5.10	Summary of the orientations of the menhirs at Nagbhid (Corrected for magnetic declination for Nagbhid on date of survey = 0^o 34'W changing by 0^o 1'/year)	174
Chapter 6		
6.1	Showing cist orientations at Chikel Chetti	179
6.2	The list of alignments for Summer Solstice Sunrise (Interchange fore-sight and back-sight for Winter Solstice Sunset)	187
6.3	The list of alignments for Summer Solstice Sunset (Interchange fore-sight and back-sight for Winter Solstice Sunrise)	187
6.4	Showing the number of k-stone alignments expected by chance versus that actually observed for k = 2 to 7	193
6.5	Showing the stones which appear to be in the position they were originally erected in	195
6.6	List of stones whose positions are Unreliable and those that appear Spurious	196
6.7	List of stones that look like they were part of one stone originally	197

Chapter 1: An Introduction to Prehistory

1.1 World prehistory in general: Prehistory concerns itself with the period of human existence before the availability of written records with which recorded history begins (Renfrew 2007). It is thus a study of those pre-literate societies of our earliest hunter-gatherer ancestors and the progress – technological and otherwise, as they domesticated animals, gradually mastered agriculture, and settled down in the earliest settlements, villages and towns. It follows the development of some of these settlements into centralised human societies and the emergence of the first great civilisations of the world. Prehistory also deals with smaller communities in some parts of the world that continued their hunter-gatherer lifestyles or as agro-pastoralists without developing into urban centres.

The story of this progress from the earliest hunter-gatherer lifestyle to the diversity of human activity today encompasses a vast span of time and is not uniform in different parts of the world. This chapter will deal with an overview of world prehistory in general and the prehistory of the Indian subcontinent.

It is important to note that our knowledge of prehistory – of the fact that the history of human origins goes back much further than the earliest evidences from recorded history, has been obtained in the last two hundred years. In early 1806, Sir Richard Colt Hoare excavated burial mounds and barrows in England and Ireland and was frustrated that the origins of the "tribes"that built these structures were shrouded in mystery (Renfrew 2007). Though as far back as 1774 Johann Esper – a German priest had found remains of cave bears and other extinct animals in association with human remains, it was the Frenchman Jacques Boucher de Perthes, who in 1846 through his publication of his finds of human artefacts like stone tools found in association to the remains of extinct animals, seriously considered this as evidence of the antiquity of man. The work that set the academic mood to receive this knowledge was undoubtedly Charles Darwin's seminal works – *On the Origin of Species by Means of Natural Selection* in 1859 and *Descent of Man* in 1871 (Kennedy 2000, Renfrew 2007). The term "prehistory" was first used, in 1851, by Daniel Wilson, in his work *The Archaeology and Prehistoric Annals of Scotland*. The term was given wider coverage by Sir John Lubbock's *Prehistoric Times*, published in 1865 (Kennedy 2000, Renfrew 2007).

1.1.1 The 3-Age system: It was the work of the Danish antiquarian Christian Jurgensen Thomsen, in charge of arranging the pre-Roman antiquities at the National Museum of Copenhagen who recognized the diversity of prehistoric artefacts and hit upon the idea of the three ages in prehistory (Kennedy 2000, Renfrew 2007). His guidebook to the National Museum published in 1836 (and translated into English in 1848), that introduced the idea of the three age system to the academic world. He had grouped the prehistoric artefacts in the possession of the museum into three groups based on the material of manufacture of these weapons and implements – which he recognized as three ages of stone, bronze and iron. He regarded these ages as a representation of chronological succession. By then, the science of stratigraphy had been established by the work of the Italian geologist Giovanni Arduino – who classified their succession into Primary, Secondary and Tertiary age groups and the British engineer William Smith, who in 1816 published *Strata Identified by Organized Fossils*.

The Stone Age was initially divided into an earlier period of chipped stone tools and a later period of ground or polished stone tools by John Lubbock (Lord Avebury) and he termed these Palaeolithic and Neolithic respectively, in his book Prehistoric Times, published in 1865 (Kennedy 2000).

Later, in the course of the discovery and study of several sites like Laugerie Haute, Les Eyzies, Le Moustier and La Madeleine in France by Edouard Lartet and Henry Christy in the mid-1800, it emerged that the Palaeolithic was not a single homogeneous period, but a sequence of prehistoric phases marked by faunal changes and changes in the lithic industries (Kennedy 2000, Renfrew 2007). The Stone Age was thus divided into The Upper, Middle and Lower Palaeolithic, with further sub-divisions as outlined in Table 1.1. These terms were coined to represent *periods* of time initially, but later came to be understood as *cultures*.

Stone tools smaller than the trademark Palaeoliths, known as microliths, were increasingly found in many deposits overlying Palaeolithic stone assemblages, which were ascribed to a period between the late Palaeolithic and early Neolithic by De Mortillet in 1883. This period was given the term Mesolithic (Middle Stone Age) by John Allen Brown in 1892. Brown further suggested that the Mesolithic was the transitional period from hunting-gathering to food-producing cultures of Europe.

Table 1.1: Showing the cultures of the Palaeolithic in relation to the periods of Glaciation

Last Glaciation	Magdalenian	Upper Palaeolithic
	Solutrean	
	Aurignacean	
	Mousterian	Middle Palaeolithic
Third Interglacial	Mousterian	
	Late Acheulian	
Third Glaciation		
Second Interglacial	Early Acheulian	Lower Palaeolithic
	Chellean	
	Pre-Chellean	
First Glaciation		

Figure 1.1: A rough stone tool identified as "concave scraper" from the Middle Stone Age found at Sannati, Karnataka, India during our explorations

Even though the concepts of prehistory outlined above had been conceived and classified in the European context, many scholars believed that these periods of prehistory had universal significance and "represented necessary stages of human cultural development from savagery to civilization" (Kennedy 2000). The basis of this view was the "psychic unity of mankind", which was the explanation for the parallel development of the same archaeological sequences in different parts of the world. The other, competing viewpoint was the "migration theory", which had invasions of populations from the centres of invention into other areas, bringing in technological and other inputs that precipitated cultural shifts. Prehistorians who favoured this view quoted the abrupt transformations in the archaeological record to support their thesis and interpreted that as mass movements of ancient populations. The extension of prehistoric studies into the continents of Asia and Africa was made with the assumption that the cultural periods and chronologies which were already defined for European prehistoric cultures could be directly applied to the archaeological records in these continents.

Though the broad elements of the framework for looking at prehistoric cultural succession still survive in prehistoric research today, the advent of objective dating systems, more sophisticated and systematic practices in archaeological excavation and identifications of technological industries and associated cultural periods have led to a detailed understanding of schemes for different geographical regions (Kennedy 2000). Today, it is understood that the stratigraphic sequences of a Palaeolithic site in Europe need not be exactly paralleled in a site from the same period in south-east Asia. Similarly, even the broad categories of Palaeolithic, Mesolithic and Neolithic etc. are not satisfactory in many contexts. For instance, strictly speaking, there is no purely Neolithic site in any of the excavated sites in India (Rao 1978). And, since there is evidence of the use of copper and/or bronze at all excavated sites in Karnataka that are from the cultural phase when man lived a settled life with domesticated animals and practice of agriculture and the manufacture of pottery, it is common for many researchers to refer to this phase as "Neolithic-Chalcolithic". These regional expressions of early copper-using cultures thus have names not used in Europe or elsewhere. This existence of a "Copper Age" prior to the onset of a Bronze Age is not universal in antiquity, and the early copper-using people do not share identical cultural elements (Kennedy 2000).

1.1.2 A rough chronology of world prehistory: Though establishing a relative chronology is difficult at best, we have a rough understanding of the timeline through advances in archaeology, anthropology, genetics, geology and linguistics. It is believed that the genus*Homo*evolved in Africa roughly 2.5 million years ago – i.e. 2.5 millionYBP (Years Before Present) (Leakey 1994).The *Homo habilis* species that emerged were the first members of the *Homo* lineage, and is definitely known to have made and used stone tools and artefacts described as the Oldowan industry (Mithen 1996). Also, it is known that *Homo erectus* populations, which had appeared by around 1.8 million years BP, had spread out of Africa and occupied large regions of Eastern and Southeast Asia half a million years ago.*Homo erectus* continued to hold sway in East Asia till 300,000 YBP, but elsewhere in Asia and in Africa, there is fossil evidence for archaic *Homo sapiens*.This early period (from 2.5 million till around 200,000 BP) is referred to as the Lower Palaeolithic, when the handaxe – a symmetrical, pear-shaped chipped stone tool was widely prevalent in almost all parts of the world, and subsequently, with the onset of the Middle Palaeolithic, there is a change in the type of stone tools used in different parts of the prehistoric world. The Neanderthal man or *Homo neanderthalensis* appears about 150,000 BP in Europe and the Near East. Fully modern man or *Homo sapiens sapiens* appears in the period between 100,000 BP and 60,000 BP, initially in South Africa and the Near East. There is evidence of co-existence of *Homo sapiens sapiens*with Neanderthals and other archaic *Homo sapiens* in Europe and the near East, where the Neanderthals existed from approximately 300,000 BP – 30,000 BP, before going extinct. In the Near East, in this period, intentional burial of the dead in pits along with grave goods was practiced by both *Homo sapiens sapiens* and the Neanderthals.In the Indian context, the oldest fossils of the Homo lineage have been found in Tamil Nadu and have been dated to 1.5 million YBP. The oldest humanoid fossils have been dated to about 120,000 years.

The Upper Palaeolithic begins in around 40,000BP in Europe and Africa, though it is unclear whether this occurs simultaneously or maybe around 20,000 BP in Asia. The Upper Palaeolithic is marked by a lot of technological advances such as profusion in the variety of stone and bone tools and artefacts, constructing dwellings, sewing clothes with bone needles etc. This is also the earliest occurrence of art – painting of walls of cave sand dwellings, carving of human and animal figurines from stones and ivory and decorating bodies of the living and the dead with beads and pendants. The first pieces of Upper Palaeolithic art came to light in the 1830's in the

Chaffaud Cave in France. This was followed in subsequent years by a host of discoveries of portable as well as parietal art (images painted or engraved on the walls or ceilings of caves) in various parts of the world (Lewis-Williams 2002), of which the cave-art of Lascaux, France and Altamira, Spain and several others are breathtakingly beautiful examples of the unbelievable skill of the Upper Palaeolithic artist.

The Middle Stone Age or Mesolithic is a brief period of transition between the Palaeolithic and the food-producing stage of the Neolithic in most parts of the world, and is characterised by the appearance of microliths (tiny stone artefacts, often a few centimetres in size) in the archaeological record. It is characteristically a few thousand years in duration after the last stages of the Upper Palaeolithic and ends with the advent of agriculture. The onset and duration of the Mesolithic varies widely in different parts of the world. Around 10,000 YBP, with the rising of temperatures worldwide after the end of the last Ice Age, we see the evidence of agriculture in the Near East, along with the domestication of animals (Mithen 1996). This phase, marking the onset of the Neolithic varies between 10,000BC to 3,000 or 2500BC in different parts of the world (See Table 1.2, Habib 2001). The Neolithic marked the beginning of settled life for humankind, though sections of the population still lived as nomadic or semi-nomadic hunter-gatherers or agro-pastoralists. The settlements of the Neolithic vary in nature and construction in various parts of the world and will be dealt with separately.

The Stone Age (Palaeolithic, Mesolithic and Neolithic) was followed by the Bronze Age in most parts of the world (Though, as we have seen, in southern India, there seems to have been copper-using cultures in the Neolithic, if we take it to mean the cultural phase when agriculture and settled life began) and later the Iron Age. Script or writing makes an appearance in the Bronze Age in many parts of the world and, by the end of the Iron Age, prehistory merges into recorded history in most parts of the world. Some researchers prefer the term “protohistory” to refer to those periods when literacy was available, but little used or little evidence for literacy survives (Renfrew 2007). Roman Britain or early days of literate civilizations in Mesopotamia and Egypt may be called protohistoric (Renfrew 2007), as possibly the Neolithic-Chalcolithic and the Iron Age in south India (Rao 1978).

The periods following the Iron Age is literate in most parts of the world and hence the beginning of recorded history in these regions.

Table 1.2: Chronology of the Neolithic Revolution (from Habib 2001)

10,000-9000 BC	Earliest Neolithic culture: Naturfian of Palestine and Syria
10,000-7500 BC	Neolithic culture, north Afghanistan: pre-ceramic
7000-5000 BC	Neolithic culture, Mehrgarh, Period I: pre-ceramic; barley, wheat cultivated
5365-2650 BC	Bagor Mesolithic, Period I: pre-ceramic
5000 BC	China, Vietnam, Thailand: rice domesticated
5000-4000 BC	Mehrgarh, Period II: hand-made ceramic, cotton cultivated
4300-3800 BC	Mehrgarh, Period III: copper-smelting; 'Togau pottery'
4000 BC	Mehrgarh: potter's wheel
3800-3200 BC	Neolithic Kechi-Beg and Hakra-ware cultures: wheel-made pottery
3385-2780 BC	Belan Mesolithic: hand-made ceramic
3500-1200 BC	Vindhyan Neolithic: mainly hand-made ceramic; rice cultivated
3000-2100 BC	South Indian Neolithic: mainly hand-made ceramic
3000-1900 BC	Swat Neolithic: ceramic; wheat, barley cultivated
2800-2500 BC	Northern (Kashmir) Neolithic, Phase I: pre-ceramic
2500-2000 BC	Northern (Kashmir) Neolithic, Phase II: hand-made ceramic; wheat, barley, lentils cultivated
2500(?)-2000 BC	Eastern Neolithic, Pandu Rajar Dhib, Period I: hand-made ceramic; rice cultivated
2100-1400 BC	Neolithic Chirand, Period I; hand-made ceramic; rice cultivated

1.1.3 Architecture in the prehistoric world: The earliest habitations of ancient human populations in the Palaeolithic seem to have been primarily caves and rock-shelters, though there is some evidence for shelters in camps in the open (Thapar 2002). The latter were made of branches and foliage; so much evidence would not survive. But evidence for occupation of caves and rock-shelters abound at many places in the world. The practice of decorating cave walls and ceilings with engravings or paintings is seen from the Upper Palaeolithic onwards (Mithen 1996, Lewis-Williams 2002).

The construction of dwellings for a settled village life is widely believed to have followed the advent of agriculture, though it is known now that at least at a few sites like those of the Early Natufian culture in the Levant (see Table 1.2), the world's first settled villages preceded the establishment of a secure agricultural regime (Renfrew 2007). The culture had pit dwellings, burials, rich stone and bone industries, mobile art and numerous tools for processing food grains – though it was still dependent on foraging. So, the evidence from these sites is clear that a markedly sedentary life style preceded farming, though it was dependent upon the availability of abundant wild food resources.

The shift from the mobile life pattern of the hunter-gatherer society to a sedentary one in the earliest settled societies is not a simple shift but one with very significant consequences (Renfrew 2007). Early settled societies implied living in one place for several years at a time, if not on a permanent basis. This involves a substantial investment of labour and materials into the construction of a permanent place of residence. This adoption of the house as the permanent context of social and economic life also heralded new ways of thinking. "The adoption of the house and the village also ushers in a development of the structure of social life, the elaboration of thinking about the structure of the world and the strengthening of the links between the two." (Wilson 1988)

The earliest villages seem to have been "egalitarian" societies, with little or no evidence for stratification of the society. The houses are more or less uniform in a village. There is evidence for collective endeavour on a considerable scale – whether for irrigation projects or for the construction of monuments, such as the substantial stone structures called megaliths in various parts of the world. The megaliths of north-western Europe, the structures termed "temples" in prehistoric Malta etc. are examples of this (Sherratt 1990, Ruggles 1999, Hoskin 2001, Renfrew 2007).

In most of the early agricultural societies, it is clear that the settlement pattern was sometimes a dispersed one of single homesteads or small groups of houses, which were built of perishable materials like timber, wattle and daub and thatch and which frequently went out of use after a few years. In this context, the erection of stone monuments – whether burials or for other purposes, seems to have provided an element of permanence that the domestic settlement itself did not offer (Renfrew 2007). This has probably led to the myth of the mutual exclusiveness of

non-domestic funerary as well as other monuments and substantial traces of domestic settlements in India (Moorti 2008) and other parts of the world (Sherratt 1990).

Domestic architecture in the Neolithic varies from the pit dwellings of Burzahom (Sharma 2000) to the timber-and-sod houses of the British Neolithic at places like Fengate and Honington (Castleden 1987) to the stone houses of Orkney and Shetland (Castleden 1987). Of the last named, the splendidly preserved site of Skara Brae is a testament to the skills of the Neolithic house builder (see Fig. 2).

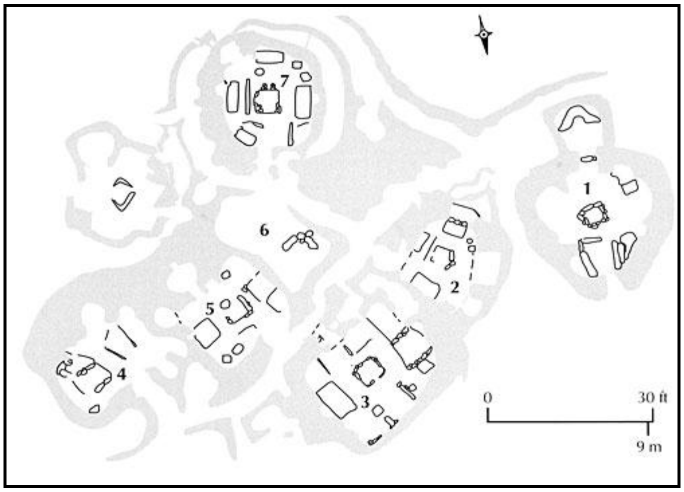


Figure 1.2: A plan of the houses at Skara Brae (Castleden 1987)

The monumental architecture of various parts of the world differed in detail, but evolutionary archaeologists see monument building as an important index of social complexity. Indeed, the construction of monuments involves the expenditure of tens of thousands of work hours (Atkinson 1956, Hoyle 1977, Castleden 1987, Renfrew 2007) and the presence of monuments indicate that the societies that built them were able to spare so many work hours from the business of eking out a livelihood from farming and other methods of food procurement.

Though recent research at the excavated site of Göbekli Tepe in south-eastern Turkey seems to suggest that the earliest phase of the structure – which is interpreted as the oldest place of worship known, can be dated as far back as the Mesolithic, most of the monumental structures of the world seem to have arisen in the Neolithic. Göbekli Tepe is part of the same culture as that of the Neolithic sites of Çatalhöyük and Jericho of present-day Turkey. Among the surviving examples of early monumental architecture of the world, megalithic structures seem to be the

most prominent. Megaliths, so termed because the earliest structures of this category that were noticed were built of large stones (derived from *megathos* = large and *lithoi* = stone) are perhaps the most durable structures ever erected by prehistoric societies and large numbers of them have survived down to recent times (Sherratt 1990). They have dominated the European archaeological imagination since the sixteenth century (Sherratt 1990) and the same in the context of the Indian subcontinent since the 1800's (Sundara 1975).

The term "megalithic culture" is a misnomer since megalithic monuments were erected at different parts of the world by different cultures (Moorti 1994). While in northern and western Europe, megaliths were erected by early farming societies in the Neolithic (Sherratt 1990), the megaliths of the Indian subcontinent are ascribed to Iron Age cultures (Sundara 1975, Moorti 1994, 2008). The Indian megaliths, which form the main subject of this investigation, will be discussed separately in this chapter and later.

A large fraction of the megaliths of the Neolithic in Europe were tombs or other mortuary structures. The earliest forms of burial monument are frequently long mounds of earth and timber, often trapezoidal in shape (Sherratt 1990).The "henge" monuments of the middle Neolithic in Britain belong to this class, as do the long barrows and mounds (Castleden 1987). Later developments include the replacement of timber by stone and the appearance of the round form. The adoption of stone as material may have been a result of desire for more permanent monuments and the preference for the large scale might have been a display of the demographic strength of a particular settlement (Sherratt 1990). The principal stone monuments include the chambered tomb, dolmens, stone circles, recumbent stone circles, stone rows and alignments and single menhirs (Ruggles 1999).

1.1.4 Stonehenge – a unique prehistoric monument: Stonehenge lies in the county of Wiltshire in central southern England, about 30 miles north of the English Channel coast about 80 miles west of London (see Fig. 1.3). It stands at a height of 330 feet above sea level, on the spread of rolling chalk downland known as Salisbury Plain (Chippindale 2004).

Stonehenge is a composite monument built over a period of more than 1500 years (Atkinson 1956, Chippindale 2004). The name "Stonehenge", which is of Saxon origin (though the building is much older), comes from the roots "stone" and "henge", or "hang". It is the place of "hanging

stones”, that is, of the stone lintels of the sarsen circle and the horseshoe. Those stone lintels, and the shaping of many of the stones into trimmed rectilinear forms, are the unique features which set Stonehenge apart from the stone circles in western Britain which it otherwise resembles (Chippindale 2004).

Figure 1.3: A aerial view of Stonehenge

The uniqueness of Stonehenge is in its intricacy of layout and re-use of features from earlier phases. The earliest phase of Stonehenge was a circular earthwork – consisting of just a ditch, bank making it similar to other causewayed enclosures of the Neolithic. Archaeologists conjecture that it may have been a tribal meeting place, with two entries into the structure aligned with the rising of the midsummer sun or the setting of the midwinter sun. In later phases, there is evidence of timber settings of which only the post-holes survive and, finally, horseshoe shaped and circular arrangements of bluestones (brought in from the Preseli Mountains in Wales, 385km away) and sarsens (natural sandstone available 30km north of the site). The outermost circle is of sarsen uprights and lintels and is 100 feet in diameter. The uprights stand 13 ½ feet above the ground and about 7 feet wide and 3 ¾ feet thick.The uprights support horizontal stone

lintels, which form a continuous circle of stone, its flat top about 16 feet above the ground. Each lintel is some 10 ½ feet long, 3 ½ feet wide and 2 ¾ feet thick. The bluestones form a less regular circle about 75 feet in diameter. The size of the bluestones vary; most are 6 ½ feet or a little more high, 3 ¼ to 4 ½ feet wide, and some 2 ½ feet thick. Inside the bluestone circle stand the other sarsen structures, five "trilithons", each consisting of two uprights under a horizontal lintel. Just within the sarsen horseshoe is a horseshoe of upright bluestones without lintels, just as there is a bluestone circle within the sarsen circle. Altogether, the monument consisted of about 162 stone blocks.

The alignment of the main axis of the structure to the rising of the midsummer sun and setting of the midwinter sun is well known (Heggie 1981, Ruggles 1999). There are many stone circles in the prehistoric Britain, but none have the complexity of structure that Stonehenge has – the horizontal lintels, the mortise and tenon joints of the uprights with the lintels and the tongue and groove joints of the lintels with each other, the deliberate use of two different materials (sarsen and bluestone) in a symbology that is lost today and the evolutionary nature of the site over 15 centuries all make this monument unique. The exact purpose for which the monument was built is still not resolved satisfactorily, though it is known with some certainty that Stonehenge was probably a "zone of the dead", with many burials nearby and that the habitations of the people who built it was at the nearby causewayed enclosure of Durrington Walls, which was probably the "zone of the living". The two were connected by the Avon River, from which a processional (?) avenue led to the monument in prehistoric times.

The exact meaning of this monument to the people who built it may never be understood, despite the attentions of researchers for a protracted period of time. The enigma of the structure is probably why it has become symbolic of all prehistoric monuments to the lay public.

1.2 Indian Prehistory – a brief overview: The Indian subcontinent has been an area for archaeological research for over 200 years. In spite of a few earlier discoveries, it is the discovery of a hand-axe belonging to the lower Palaeolithic stage in a gravel pit at Pallavaram near Madras, by Robert Bruce Foote – a geologist of the Geological Survey of India on 30 May 1863 that can arguably be called the most important milestone in the study of Indian prehistory (Kennedy 2000). This discovery inspired geologists working in other parts of India, and soon they were reporting Palaeolithic and other types of prehistoric tools and their contexts from those

areas. Foote himself went on making discoveries in Andhra, Tamil Nadu, Karnataka and Gujarat. His collection is today housed at the Government Museum at Chennai.

Since the days of Foote, a wide range of of studies have been carried out on Indian prehistory. “We have so far probed practically all parts of India and we can now establish our own identity of prehistoric man and environment in relation to similar evidences in other countries.” (Joshi 2004) On the basis of all these studies, we can reconstruct a reliable, although patchy, account of the history of human habitation on the subcontinent.

1.2.1 The Phases of Prehistoric Human Occupation in India: The earliest humans (*Homo habilis* or *Homo erectus*) appeared in the Salt Range (Pakistan) and Siwaliks (India) about two million years ago, just before the beginning of the geological epoch of Pleistocene (Habib 2001). The discovery of a true hominid fossil at Hathnora in the Narmada Valley by Arun Sonakia of the Geological Survey of India in 1982 was the first hominid fossil find in India (Chakrabarti 1999). This specimen, believed to be the fossilised skull of a male hominid, dates from the Middle Pleistocene and belongs to the *Homo erectus* variety of hominid fossils. There is evidence for tools and fossils from the early or pre-middle Pleistocene (730,000 to 130,000 years ago) from various parts of India like the Siwalik Hills. Over the years, evidence has accumulated for human occupation during the lower, middle and upper Palaeolithic. Where clear stratigraphic profiles are available, a clear evolution of the lithic industry undergoing transformations from the middle to upper Palaeolithic, are noticeable.

A patchy chronology has also been arrived at using various dating techniques. Though most methods are based on the decay of radio-isotopes, other methods like thermoluminiscence (TL), Electron Spin resonance (ESR), magnetic reversals and a method based on racemization of the amino acid isoleucine have been employed to date fossils, tools and the strata in which they were found.

Palaeolithic sites in general date from before 30,000 to about 10,000BC (Thapar 2002). Evidence is usually in the form of stone tools – hand-sized and flaked-off large pebbles, though a skull found in the Narmada Valley adds to our understanding of Palaeolithic Man in India. There is evidence at a few sites for attempts to domesticate animals and the manufacture of crude, hand-made pottery. There is very little evidence of expression of their world-views and belief-systems,

though a few rock-paintings at Bhimbetka – more well-known as a Mesolithic site belong to this period.

A region-wise description of the Indian Lower, Middle and Upper Palaeolithic is given below (Chakrabarti 1999).

North-west: The Sanghao cave sequence, which dates from the Upper Palaeolothic, yields dates that show an even spread between 41,825 BC and 20,660 BC. At the sites of Jalapur and Dina in the Potwar plateau, the Lower Palaeolithic has been dated at 600,000 – 400,000 BP, whereas a minimum date of 45,000 BP has been estimated for the Upper Palaeolithic at Riwat in the same region.

Western Rajasthan:Data from Didwana places the Lower Palaeolithic at more than 390,000 BP, the Middle Palaeolithic at 150,000 BP and the Upper Palaeolithic at 26,210 BP.

Saurashtra (Gujarat): Dates come from the Hiran valley stratigraphic profile: the Lower Palaeolithic – roughly between 190,000 and 69,000 BP, the Middle Palaeolithic – 56,800 BP.

Madhya Pradesh: The Son Valley: Lower Palaeolithic – more than 103,800 BP and the Upper Palaeolithic – between 10,000 and 12,000 BP. The Narmada and Chambal systems: upper Palaeolithic 36,550 BP (Chandrasal), more than 31000 BP (Nagda), 41,900 BP (Mehtakheri).

Maharashtra: The Lower Palaeolithic for Nevasa is estimated to be more than 350,000 BP and the earliest dates for the Upper Palaeolithic for the region are 27,000-25,000 BP.

Karnataka: At Yedurwadi in the upper Krishna Valley, the lower Palaeolithic is earlier than 350,000 BP. Teggihalli in the Hunsgi-Baichbal section has two lower Palaeolithic dates – more than 350,000 BP and 287,731 BP, whereas Sadab in the same area gives 290,405 BP.

Andhra: Only Upper Palaeolithic dates are available from the Kurnool caves. TL dates show 17,390 BP while ESR techniques give 16,686 BP.

Uttar Pradesh: Only Upper Palaeolithic dates are available from Belan valley – with earliest date being 25,000 BP and last date around 9,000 BC.

As can be seen from the data presented above, a fairly comprehensive chronology of the homo lineage in the subcontinent has been obtained in archaeological research. Comparatively, the number of early Mesolithic dates available for India is woefully limited and confined to a handful of sites. These, which range from Bhimbetka in Madhya Pradesh to Bagor in Rajasthan and Sarai Nahar Rai in Uttar Pradesh, yield dates for the Indian Mesolithic between 4480 BC and 8400 BC. The famous painted rock-shelter complex of Bhimbetka belongs to this period of occupation. Sites of the Mesolithic show the use of microliths as stone tools; these being small (less than 5cm) tools like flakes, blades, burins, points, scrapers, crescents etc. This technology allowed for hunting animals from a distance (using bows and arrows) and utilised other types of stones like chert, agate, quartz and chalcedony (Thapar 2002). It is surmised that the new technology induced a change in living patterns and eventually resulted in a tendency to settle for longer periods, paving the way for the settled life of the Neolithic – with its agriculture and domestic animals.

An important phase in Indian Prehistory is the Indus or, more appropriately, Harappan civilization, representing the first urbanisation in the Indian context. This Bronze Age Civilization, more than 1050 sites of which are known today,covered an area of more than 100,000 square km (Possehl 2002) and includes cities, villages, craft centres, river stations, camp sites, fortified palaces and ports (Ratnagar 2001). The outermost site of this civilization is Shortughai in north-eastern Afghanistan, with a site count in 1984 showing about 138 classic Indus civilisation sites in Uttar Pradesh, Haryana, Punjab and Rajasthan and a site count for Gujarat showing 101 classic Harappan sites. Mohenjodaro, Harappa, Dholavira and Kot Diji are some of the important sites of this civilisation. This civilisation can be placed as existing between 2800 BC and 1300 BC, though the earliest occupation of some of the sites date as far back as 3300BC (Ratnagar 2001). Some features that make the Harappan Civilisation unique for its times is the fact that it was spread over an immense geographic area with several urban centres, had baked-brick buildings and well-developed architectural skills, had a standardized weight system and had long-distance trade with other contemporary civilizations (Ratnagar 2001).

During this same period, the Neolithic-Chalcolithic was extant in other parts of the subcontinent (Allchin and Allchin 1996). Neolithic sites occur in different parts of the Indian subcontinent.

Notable among these are Galighai in the Swat Valley, Darai Khola further to the south, and in the loess (karewa) plateau of the Kashmir Valley where there were pit dwellings; in Chirand, Bihar and in sites in the Belan Valley of Uttar Pradesh – with sites such as Chopani Mando and Koldihva; eastwards to Pandu Rajar Dhibi and further to Daojali Hading and Sarutaru; and in a cluster of sites spreading out from the Raichur doab and the Godavari and Krishna Valleys in the peninsula at Utnur, Piklihal, Maski, Tekkalakota, Brahmagiri, Hallur, Paiyampalli and T. Narsipur (Thapar 2002).

As seen earlier, the onset of the Neolithic is different in different parts of the world and in India (see Table 1.2 above). Mehrgarh, near Quetta in Baluchistan, is one of the earliest Neolithic sites on the Indian subcontinent, with an origin dated to *c*. 7000BC and being one of the precursor sites to the Harappan civilisation. The existence of an urban culture in north-western India did not envelop the other contemporary pre-urban societies. The Neolithic sites of Burzahom and Gurfkral in Kashmir that date to nearly 3000BC seems to have had links to the Harappan Civilisation, evidenced by the finding of carnelian beads of Harappan origin and a pot with a horned "deity" of Kot-Dijian (Kot Diji is a type site for the pre-urban Harappan civilisation) design at Burzahom; but these are seen as evidence for visits by the Harappans in search of mineral wealth to sustain their metal-making requirements (Ratnagar 2001, Thapar 2002).

In southern (peninsular) India, a summary chronology for the three phases of the Southern Neolithic is as follows: Phase III: 1600-1000 BC; Phase II: 2000-1600 BC; Phase I: 2500-2000 BC (Ehrich 1992). The Neolithic is when man is believed to have lived a settled life, domesticating animals, practicing agriculture and making pottery. In south India, especially in Karnataka, there is evidence for the use of metal – copper and bronze in all excavated sites, thus prompting the use of the term Neolithic-Chalcolithic for this period (Rao 1978), as mentioned earlier. The Neolithic Revolution, as Gordon Childe termed the change in life-pattern due to agriculture, "was not a sudden, radical change, and some activities of the earlier age had anticipated these developments" (Thapar 2002). The part of south India where this phase of "new patterns of subsistence" first developed is part of the Deccan plateau, with a landscape of vast plains of black cotton soil from which granite hills rise up (Allchin and Allchin 1996). Unique to these early Neolithic settlements are the features called ashmounds, which will be discussed in detail in a later section.

After this phase came the emergence of the Megalithic Complex of South India, which represents one of the most perplexing problems in South Asian archaeology. Continuity from the Neolithic to the Megalithic period is seen from the ceramics, especially the White-painted Black-and-Red-Ware (Ehrich 1992). The use of iron coincides with this cultural period and forms and adjunct of Megalithic culture (Moorti 1994, Moorti 2008). There is, then, considerable evidence for continuity between the Neolithic and the Iron Age in the southern reaches of the peninsula, also suggesting that the causes for transition is within south India and not across the seas (Ehrich 1992). Evidence from recent research also points to the possibility that the practice of erecting megaliths could have begun as early as the middle Neolithic (Morrison 2005, Bauer, Johansen and Bauer 2007). This will be discussed in detail later.

The current understanding of the chronology of prehistoric south India is summed up in Table 1.3 (Bauer, Johansen and Bauer 2007).

Table 1.3: Summary of the south Indian prehistoric from the Neolithic (Bauer, Johansen and Bauer 2007)

South Indian Neolithic	3000 – 1200BC
Iron Age	1200 – 500BC
Early Historic	500BC – 500AD

1.2.2 Architecture in prehistoric India: In the early hunter-gatherer societies of the Palaeolithic and the Mesolithic, habitations were mostly in caves and rock shelters like at Bhimbetka in Madhya Pradesh or Sanghao cave in north-west Pakistan or Kurnool in Andhra Pradesh (Allchin and Allchin 1996, Thapar 2002). There is lesser evidence for habitations in camps in the open, since these were built of perishable material like timber and foliage. As mentioned earlier, many of the rock shelters inhabited especially during Mesolithic and later times have been decorated with rock art. At sites like Bhimbetka, where a few rock art panels date back to the Palaeolithic and occupation as well as the tradition of rock art continued well into the Early Historic period (Thapar 2002), it is possible to see a record of lifestyles as seen through the eye of artists of those periods – the earliest scenes depict the hunting of animals while the latest depict scenes of elephants and horses in processions, battles etc.

There are instances of intentional extended burials with mostly east-west orientations for the bodies during the Mesolithic, occasionally within the habitation area, with the interment of grave-goods such as microliths, shells, pendants etc. perhaps pointing towards an idea of after-life (Allchin and Allchin 1996, Thapar 2002).

The settlements of the Neolithic had a variety of dwelling types. The earliest phase of Neolithic Burzahom (before *c*. 2920BC) hadwhat appear to be pit dwellings, with post-holes around the perimeter on the surface indicating conical thatch roofs over posts (see Fig.1.4). The floor and walls of the pits were often mud-plastered and the pits are usually narrow at the top and widen towards the base.

Figure 1.4: A view of one of the "pit dwellings" of Burzahom

Later periods of the Neolithic at Burzahom left traces of circular as well as rectangular houses of mud and rubble or mud-brick, sometimes with mud plaster (Allchin and Allchin 1996, Sharma 2000). Burzahom and a few other Neolithic sites in Kashmir, like Gurfkral, have large menhirs associated with a later megalithic phase, which has been interpreted as due to the arrival of "megalithic people" at the site, though the antiquities recovered from this megalithic phase are seen to be similar to those of the preceding Neolithic (Sharma 2000). This has been in turn

interpreted as proof that the Megalithic newcomers co-existed with the Neolithic occupants of the site, who continued their traditions and culture and that the two cultures “got assimilated in each other in course of time.” The Megalithic phase in Kashmir seems unconnected to that in peninsular India and also might have occurred earlier (Sharma 2000). There are instances of burials with domestic dogs interred with their masters at Burzahom.

Houses in other Neolithic/Chalcolithic sites in the subcontinent, such as Ahar near Udaipur, Navdatoli on the banks of the Narbada near Maheshwar show traces of houses either oblong or round in plan, with walls of stone and mud or mud brick and possibly wattle and daub. Chalcolithic settlements in Maharashtra, such as Nevasa, Daimabad, Chandoli etc. had rectangular houses with wooden frames and wattle and daub infill or circular shallow pits with post-holes around. They had cooking hearths and storage areas and shallow hollowed bases for standing pots (Allchin and Allchin 1996). Extended burials were characteristic of the early phase with multiple urns, often mouth-to-mouth holding selected bones or skeletal remains of children being seen during the course of the second millennium BC.

The early phase of the Neolithic of southern India starting about 3000BC is associated with the ashmound sites like Kupgal and Utnur in Andhra Pradesh and Piklihal in Karnataka. The ashmounds may have been cattle pens used for capturing wild cattle and/or herding of domestic cattle thereafter, with periodic firing for hygiene or ritual purposes (Allchin and Allchin 1996) but their role as monumental structures in those early societies are also conjectured (Johansen, 2004, Bauer, Johansen and Bauer 2007). This phase was followed by one of settlements of a more permanent nature on the slopes and tops of granite hills, lasting from c. 2100BC to c. 1700BC. These settlements consisted of circular hutments of wattle and daub on wooden frames, with earthen floors. The next phase, which lasted till the Iron Age, is characterised by developments similar to the Chalcolithic in Maharashtra, with circular huts utilizing larger boulders as building material. Burials were extended inhumations, with urn burials similar to Maharashtra for infants. All burials were within habitation areas.

The ashmounds of the south Indian Neolithic are an interesting feature, the exact nature of which is still debated. They are deliberately created mounded features formed by heaping and burning accumulations of cattle-dung. These structures, which vary in size from 28 m2 to 4951m2, are confined to the south Deccan-north Dharwad region (Johansen 2004). More than a hundred

ashmound sites are known, though only a few have been subjected to archaeological examination. Though a variety of colourful local legends try to explain the ashmounds through mythical associations, archaeologists have long believed that they arose out of either functional necessity to burn accumulations of cattle-dung to prevent the proliferation of vermin associated with animal faecal matter or, more likely, episodic ritual burning of dung (Johansen 2004, Boivin et al 2008).

Figure 1.5: A view of the ashmound at Kudatini (Boivin et al, 2008)

Ashmounds are obviously products of a strong pastoral culture, given the large accumulations of dung that went into their creation. Recently they have been recognised as important monumental spaces within the cultural landscape of south India’s Neolithic agro-pastoralist inhabitants. Johansen (2004) has demonstrated that they are examples of monumental architecture, “capable of conveying a range of socio-symbolic meaning in a clear and legible manner.” He has argued using the four visual dimensions of perception, viz. clarity of form, contrast with background, prominence and sufficiency of mass to emphasize presence, to make a case that the ashmounds were deliberately built monumental structures of significance in the social landscape of the Neolithic cultures. Earlier studies by Paddayya (1991) which establish the location of ashmounds at the centres of Neolithic and even post-Neolithic scatters seem to confirm the role of these structures as monuments of importance. It is tempting, though probably imprudent, to draw parallels to the early “henge” monuments of the British Neolithic such as the earliest phase of Stonehenge, which were circular enclosures bounded by mounded structures of earth that served as communal meeting places (Osborne 1995) or ceremonial tribal centres (Castleden 1987).

There is evidence that, despite the significant changes in social organization, economy and landscape production with the transition from the Neolithic to the Iron Age (Moorti 1994, 2004, Brubaker 2001), many ashmounds continued to be important monumental places involved in ritual activities in the Iron Age cultural landscape (Johansen 2004). There is a large amount of evidence from megalithic sites of ashmounds being occupied by megalithic cultures and incorporated into the scheme of megalithic monument complexes as well as the ash from these structures being used in megalithic mortuary practices.

Figure 1.6: The severely disturbed megalithic site of Chik Benakal

One of the best examples of association with the later megalithic structures with ashmounds is described by Meadows-Taylor (1941). He describes a massive megalithic structure erected on an ashmound, about 20m in diameter, which was faced with and surrounded by eight perimeters of stones and surfaced with a layer of soil with a stone circle megalith on the top surface. Paddayya and Allchin also noticed similar construction of megaliths atop ashmounds in nearby regions. There are also the rare typology of "ash circle graves" of the Iron Age found at sites like Rajan Koluru, Chik Benakal (see Fig. 1.6), Piklihal and Lingsugur, where a circular surface layer of dung-ash covers both stone circle and dolmen type of megalith. In all these cases, there are

ashmounds existing in the vicinity and it is probable that ash from these mounds might have been used in the construction of the megaliths.

1.3 The megaliths of the Indian subcontinent: Megaliths have fascinated the lay public and the archaeologist and antiquarian alike for ages because of their "curious and bold appearance on the surface" of the earth (Sundara 1975). Megalithism seems to be a "world phenomenon" – their occurrence from the shores of England to that of Japan unquestionably catches one's imagination (Moorti 2008). Almost throughout the Old World, these ancient stone structures have been noticed and various theories have been propounded to account for their origin and spread. However, Moorti (2008) cautions that "it may be safer to outline the distribution of megalithic monuments but forming opinions on their spread is nothing less than walking on a hotbed of controversies."

The European megaliths are considered as earliest in the chronological sequence. Traditional views derived the whole megalithic complex of Europe from the East Mediterranean which trace the spread of the custom by a seafaring people moving northward, through Spain, up the coast of Western Europe and into Scandinavia. This custom is believed to have been long in prevalence – from Neolithic to the Bronze Age (i.e. from *c*. 5000 to 2000 BC) and its continuation even in the Iron Age. A majority of European archaeologists today believe that the development of "megalithism" was indigenous (Sherratt 1990), though probably having different independent centres. However, many of them tend to agree with Mackie's version of "modified diffusionism" in the diffusion of ideas and think that it occurred along the seaboard from the Atlantic Coast toward the interior.

However, this has been seriously challenged by the recent genetic data which suggests that the Homo sapiens arrived into the subcontinent along the sea about 30,000 years ago and then spread out of the Indus region where they met other groups of Homo sapiens coming via central Asia and Mesopotamia. If this scenario is confirmed with further data, it is possible that that roots of human culture in India may be older than that in Europe.

In South Asia, parallels have been drawn from south Russian/Caucasian tombs like the long barrow, port-holed cists of Tepe Sialk IV (in Iran), sarcophagus tombs of Philistan (located along the southern coast of Palestine), the rock-cut caves of Kunama in north Ethiopia, cists and stone

circles of Makran coast which have been taken either as the areas of inspiration or wherefrom migration of people took place having this "megalithic" trait – i.e. the cultural practice of erecting megaliths. Notwithstanding the chronological difficulties, some of the above-mentioned regions are thought to be the probable areas wherefrom the "megalithic" custom spread. Lasting for over 1000 years (from *c*. 1500 BC to the early centuries of the Christian Era) the majority of the megalithic burials is associated with the Iron Age communities of South Asia.

On the Indian subcontinent, the area between the Vidarbha region of Maharashtra and the tip of the southern peninsula constitutes the major zone of the burial style denoted by the various types of megaliths (Chakrabarti 1999, Brubaker 2001). Till recently, megaliths were supposed – quite wrongly – to have formed an independent cultural entity in this region. However, it is now clear, especially after the excavations of sites like Watgal in Karnataka and Bhawar in Vidarbha, that it is nothing more than a burial style which emerged in the context of the Neolithic-Chalcolithic of its distribution area and formed part of its cultural milieu for a long time. Generally, it is associated with iron but there is also a possibility of its beginning in the pre-iron stage, a conjecture which is now being taken very seriously after Morrison (2005) has re-analysed carbon samples from Wheeler's excavation of Brahmagiri in the 1940's and suggested that the construction of megaliths may have started in the middle Neolithic.

1.3.1 The megaliths of south India: It is well-known that in India, the Deccan or Peninsular India contains a very large number of megalithic structures – since the first reports of "Pandu Coolies" in Kerala by Babington (1823). In the decades that followed, hundreds of megalithic sites have been discovered in southern India. Several of them have been excavated, studied and classified; among them the most celebrated study being that of Brahmagiri. Brahmagiri has been intensively explored by M. H. Krishna in 1940 (Krishna 1942, Ghosh 1989). Later on R. E. M. Wheeler excavated the site on behalf of the Archaeological Survey of India in 1947 (Wheeler 1947, Ghosh 1989). Since those days, studies of Indian megaliths have come along way and a lot of these sites have been systematically studied, though megaliths continue to be one of the most perplexing problems in South Asian archaeology (Ehrich 1992).

The etymology of the word "megalith" comes from the words "*megathos*" – referring to the scale and "*lithoi*" – referring to the material. Thus, megalith literally means "built of large stones". This terminology arose because the earliest monuments belonging to this category to be noticed

were the ones with the most impressive surface markers. As is known today, not all the monuments that are today categorized as “megaliths” are built of large stones! The usage of the term “megalithic”, however, is justified because of its antiquity and continued popular use. The term denotes in the present context a socio-religious expression of burying the deceased in a grave (which may or may not have a lithic appendage) accompanied by certain specific cultural traits of the period under reference (Moorti 2008, Moorti 1994).

According to current understanding, megaliths may be defined as a class of features constructed of locally available stone and, in some cases, earth, including excavations in soft rock for sepulchral, memorial and other less understood purposes. Their form ranges from simple cobble-boulder- and stone block-filled crevices and other natural features on granite outcrops as at Hire Benakal (Fig.1.7) to elaborately conceived and executed dolmens (Fig.1.8), underground cists, boulder circles, menhirs, alignments and some other forms. The form, architecture and classification of megaliths of the Indian subcontinent will be discussed in a later chapter.

Figure1.7: A "rock-shelter chamber" megalith at Hire Benakal

Figure 1.8: Dolmens of the central group at Hire Benakal

A large majority of these monuments is funerary in nature. However, the funerary aspect of this tradition is not entirely a new feature of the Iron Age. The antiquity of burial practice in India dates back to the Mesolithic period and marked burials begin in the Neolithic (Agrawal). Though evidence for an antecedent stage of "megalithism" is found in the pre-Iron Age context, this tradition became very popular in the Iron Age and continued to survive into the Early Historic and even later periods. Also, several prominent megalithic typologies such as stone alignments and avenues are not sepulchral in nature. In fact, while discussing the well-known stone alignments at Vibhutihalli, Sundara (1975) even mentions that they may not belong to the south Indian megalithic cultural complex and that the chronology of monuments such as these is uncertain. He ascribes their inclusion as a megalithic category to the proximity to sites with cairn stone circles etc.

1.3.2 The distribution of megaliths in India: Though a few megalithic sites have been reported from North India, (e.g. Burzahom – see Fig.1.9, Gurfkral in Kashmir; Gagrigol in Kumaon area), by far the large majority of megaliths are found in the southern part of the country (Brubaker 2001). The various megalithic types encountered are stone circles, dolmens, dolmenoid cists and cist burials, pit burials etc., apart from menhirs, stone alignments and avenues, as well as rock-

cut chambers and the unique topikals and kudaikals of Kerala. In fact, in spite of this apparently bewildering variety of typologies one finds distributed all over the subcontinent, they can be classified into a few broad categories (discussed in detail later).

There seems to be a lot of similarity in the megalith types separated by large geographical distances; e. g. the dolmens and dolmenoid cists of Hire Benkal in Karnataka, the cists of Wheeler's Brahmagiri excavations and the dolmenoid cists of Chagatur in Andhra Pradesh are all remarkably similar in planning and execution, differing only in their positioning above the ground, partially or fully underground. Similarly, one finds stone circles and cairn circles laid out in identical manner at sites in Tamil Nadu and Karnataka. This will be discussed in detail in the chapter discussing megalithic architecture. There also seems to be evidence for distinct megalithic traits in different geographical zones within a broad region, with overlap in the contact area between zones (Rajan 1998). Urn burials were popular in the earlier Neolithic-Chalcolithic period and the prevalence of the urn burial marked by stone circles and suchlike on the surface may indicate assimilation of megalithic traits by the indigenous people.

Figure 1.9: A view of the megaliths at the Neolithic village-site of Burzahom

In certain regions of South India, several types of megaliths are encountered. In the Palani hills, one can find dolmens, cists and urn burials (Rajan 2005, Anglade and Newton 1928). The curious non-sepulchral (apparently) megalith form called stone alignment is commonly found abundantly in the present day states of Andhra Pradesh and north-western Karnataka (Allchin 1956 and Paddayya 1995). Stone alignment sites are supposed to be found only in the Shorapur and Raichur Doabs in Karnataka (Sundara 1975), though in the course of the present studies, we will show that that a few of the menhir sites encountered in coastal Karnataka are in fact alignment or avenue sites. Menhirs are found virtually all over the subcontinent – like Maski (Thapar 1957), Managondenahalli, Nilaskal (Sundara 1975) (Fig.1.10) and other places in Karnataka, several sites in Andhra Pradesh, Tirukkoyilur in Tamil Nadu (Rajan 1998), Anapara and other places in Kerala (Moorti 2008, Mathpal 1998) etc.

Figure 1.10: A menhir at Nilaskal, Karnataka

Endemism is also encountered while studying the distribution of the various typologies. For instance, cairn circles and stone circles dominate the Vidarbha region of Maharashtra (Mohanty 2005). Leshnik (1972) asserts that urn burials are common in the south-east along the Madras seaboard and the caves (catacomb tombs), today called rock-cut burials are restricted to the

Malabar coast (present-day Kerala and South Canara). The uniquely endemic Kudaikals and Topikals of Kerala are well known (Mathpal 1998).

1.3.3 Chronology of the Indian megaliths: A crucial aspect in building up a coherent picture of any archaeological culture period is a substantial dating base. As stated earlier, the chronological sequencing of the Megalithic Complex of South India is far from satisfactory, though radiocarbon dating has given us a broad picture of the period with which we are concerned (Moorti 2008, Ehrich 1992). This becomes apparent when one considers the absolute dates available for the known megalithic sites. For a total in excess of 2000 known megalithic sites, absolute dates are available only for about 30 sites! On the basis of available data, the dates for the following geographical regions are as follows:

Gurfkral, Kashmir valley (*c*. 1888-1671 BC), Gagrigol, Kumaon area (*c*. 2666-2562 BC), Mirzapur area, Vindhyan region (*c*. 1300 BC), Rayalaseema plateau, Kalyandurg area (*c*. 1880-1595 BC), Upper Tungabhadra valley, Davanagere area (*c*. 1440-930 BC), Cudappah basin, Tadpatri area (*c*. 1375-1230 BC), Upper Tungabhadra valley, Hirekerur area (*c*. 1385-835 BC), Tambraparani plain, Palayankottai area (*c*. 905-780 BC), Nagpur plain, Nagpur area (*c*. 800-405 BC), Javadi Hills, Vellore area (*c*. 425-155 BC), Baramahal, Tiruputtur area (*c*. 805-25 BC), Upper Cauvery valley (*c*. 225 BC), Krishna-Tungabhadra doab, Kurnool area (*c*. 1675 BC-AD 35), Warangal plateau (*c*. 185 BC-AD 35), Upper Krishna valley (*c*. 160 BC-AD 70), Kongunad upland, Tiruppur area (*c*. 300 BC-AD 100) (Moorti 2008).

It was cautiously put forward on the basis of the available dates that this culture existed from about 1500 BC to about 300 BC, the terminating phase as evident from script, coinage and growth of urban centers from this time onwards (although by no means a uniform scene for the whole geographical area implicated). But obviously, the megalithic tradition continued in later centuries too and it forms a part of early historical cultures in the beginning. This scheme has been called into question by the re-analysis of wood samples from Wheeler's (1948) excavation of megaliths at Brahmagiri by Morrison (2001), which yielded calibrated dates between 2140 and 1940BC, which puts it in the Southern Neolithic. Though only further radiometric dates from megaliths throughout the range of occurrence can help us place the practice of their construction in a proper chronological framework, these early dates suggest that the practice must have existed for a very long period.

1.3.4 Settlement sites of the megalithic age:

"... A thousand megalithic cists might be excavated with the utmost care without any significant addition to our knowledge of their chronology. Only by placing their culture in a related culture-sequence, such as an adjacent town-site could alone be expected to provide, was it possible to ensure a substantive advance of knowledge."

Mortimer Wheeler, 1948, *Ancient India 4*

It was this belief of Wheeler that led to him selecting Brahmagiri for his celebrated excavations (Sundara 1975). A sequence of three cultures, viz. the Early Historical, the Megalithic and the Neolithic cultures and distinct overlaps between them in turn, were methodically and unambiguously discovered as a result of his excavations.

In general, archaeologists have felt – quite erroneously – that there is an absence of "identifiable habitational remains" of the Megalithic communities of South Asia (Moorti 2008). Many authors, such as Leshnik (1972), Allchin and Allchin (1996) have contributed to this viewpoint. However, in 1994, when 1930 Megalithic burial sites were known, 176 habitation or habitation-cum-burial sites were identified without doubt, in addition to 217 doubtful habitation or habitation-cum-burial sites (Moorti 1994). More studies have to be done to understand the "spatial patterning of tombs within the settlement landscape".

From excavations such as those at Paiyampalli, Hallur, Brahmagii, Maski etc. it has emerged that the domestic architecture of the Megalith builders were circular, oval or oblong in plan and were probably made of perishable materials like wattle and daub and thatched or reed roofs, as evident from post-holes, parts of floors etc. (Sundara 1975).

1.3.5 Pottery: The characteristic ceramic repertoire of the Megalithic sites of south India are the Black-and-Red-Ware (plain and white painted varieties), Black, Red, Russet-Coated and Painted- and Micaceous-Red-Wares (Agrawal). Regional variation in the distribution of ceramics is also recognized – for instance, the Russet-Coated and Painted-Ware which is mainly associated with the western-interior peninsula and Kerala, is absent along the east coast; the Micaceous-Red-Ware is confined to the Vidarbha region.

The Black-and-Red-Ware, considered as a "necessary cultural adjunct" of Megalithic burials, has a long history of not less than 2000 years (Moorti 1984). The occurrence of this ware in different

cultural periods, viz. in Chalcolithic, Iron Age and Early Historic period is quite interesting and may indicate the preference in continuing a tradition by different communities. The Black-and-Red-Ware is a special kind of pottery. The two-colour effect on the same pot is believed to have been produced by the "inverted firing technique" – in which the lower portion of the pot, as also the the inside of it is in contact with the reducing flame present in the combustible material and this turns the clay in these areas black while the top portion of the pot exposed to the air turns red as a result of oxidization (Dey 2003). Its prevalence before the Iron Age and it gradually becoming a part of the Megalithic Culture of South India is now well known – why, when and where it became so needs to be probed further.

Morrison (2001) mentions that at Hallur, BRW is associated with a date of 1430-902BC, while a megalith excavated at Halingali containing BRW and Red Ware gave a date of 190BC-310AD, testifying to the long use of the pottery fabric in prehistoric societies in southern India.

1.3.6 Socio-economic basis for megalithic society: It has been for long held that the megalith builders were agro-pastoralists of South India. However, it is recently that the quantitative evaluation of the material data of the Megalithic period, as also its collation against an ecologic and systemic framework, has indicated that a combination of specialized strategies, i. e. agriculture and cattle pastoralism, was adopted at the societal scale of production (Moorti 2008). It is important to note that a majority of the settlement sites are located either on the banks of major rivers or on their major tributaries and most of the burial sites are situated within a distance of 10-20 km from the major water resources.

The following facts may also be suggestive of this subsistence strategy:

1. the maximum concentration of their sites in river valleys and basins and preference shown towards occupying black soil, and red sandy-loamy soil zones;
2. the distributional pattern of these sites in rainfall zones where the average annual precipitation ranges from 600 to 1500mm; as also
3. the occurrence of maximum number of sites mainly in tropical dry deciduous, tropical thorn and tropical moist deciduous forest zones avoiding as they did other dense forest zones (Moorti 2008, Moorti 1994)).

Their subsistence base seems to have been a specialized agro-pastoral economy dominated by cereal, millet and pulse production. There is evidence for the occurrence of wheat, rice, barley, kodo millet and pulse crops in Vidarbha; barley, rice, kodo millet and pulses in the Middle Krishna Valley and Andhra Ghats south area; and the remaining parts of South India have mostly produced the evidence for rice, ragi, kodo millet and pulses. Cattle (including buffalo) predominates over other domesticated species and accounts for more than 60% of the total faunal assemblages; whereas sheep/goat accounts for only 10-15% and was next only to cattle in importance.

There is enough evidence that many of the known 400 settlement sites of this period testify that industrial activities such as smithery, carpentry, bead making and pottery manufacturing were carried out, displaying as they do a highly developed tradition in these crafts. The items of exchange seem to have consisted of iron tools and weapons, copper and gold ornaments, semiprecious beads and pottery. Metal working was of very high quality, as evidenced by the study of the various metal artefacts at some of the sites (Mudhol 1997). The location of several Megalithic sites on the known early historical trade routes leaves a strong possibility of these acting as places/centers for exchange.

Although no comprehensive attempt has been made so far to understand the Megalithic religion and ritualism, the basic objective of archaeologists have been to know the role of religion and ritualism as part of the ideological system of the Megalithic society. The main sources of information in this regard are the burials as they form a prominent feature and are crucial in understanding some of the ideological facets of the Megalithic society (Moorti 2008). For instance, it is becoming increasingly clear that the Megalithic burial monuments were meant to hold only a very restricted number of persons, and the burial took place in them rather rarely, once or twice in a generation. It is also likely that these burials reflect only a certain (upper?) segment of the society.

There is evidence for numerous references to “Megalithic” burial tradition found in the Sangam Tamil literature that suggests that the society that produced the literature and the megaliths were one and the same in Early Historic Tamil region (Selvakumar 2005). The Iron Age-Early Historic “Megalithic” people gave more importance to the cult of the dead than their

predecessors. There seems to have been a cult of the dead that amounted to general respect for the dead, ancestor worship and hero worship in this region at least.

The south Indian megalithic complex – outstanding issues: Though the nearly two centuries of academic attention has resolved many questions about megalithic monuments, the societies that built them and the lifestyles and belief systems of their builders, several issues still remain unresolved. Apart from the very fundamental problem of chronology dealt with already, there remainother important problems like the purpose of erection of the megaliths that did not serve as burials or memorials, a proper understanding of the knowledge-systems of the megalith-builders, possible continuation and relationship with monumental architecture of the preceding and succeeding cultural phases etc.

As described in detail in Chapter 4, megaliths are classified into sepulchral and non-sepulchral types as a first level of differentiation. However, the non-sepulchral category lumps together megalith-types of seemingly widely varied possible purposes – such as the dolmen, which is most likely memorial in function, and the stone alignment or avenue which do not appear to be similar in function. Furthermore, there is the possibility that the different types of stone alignments may have had differing purposes. Taking all this into account, it is prudent to concentrate on the difference between the various types of megaliths, just as once it had been necessary to understand the widely varying forms as different expressions of the same cultural practice.

The knowledge systems of the megalith-builders pose another difficult challenge to unravel. Judging by the knowledge of geometry and engineering skills evident in construction of a wide variety of forms using large and heavy blocks of stones in many cases, it is highly likely that megalithic man had an advanced level of philosophical thought and views about the world. Since these megalith-building societies were pre-literate, their material culture holds the only key to understand their knowledge- as well as belief systems, apart from their rock art. Examples of prehistoric rock art are fairly common throughout the subcontinent from the Mesolithic onwards, and at several sites like Onake Kindi near the important megalithic site of Hire Benakal (see Fig.1.11), have been identified as belonging to the same culture that the megaliths are attributed to. Rock art, which mostly depict either aspects of day-to-day life of the period of its origin or

geometric patterns, and rarely, seemingly abstract philosophical beliefs of the artist, may hold vital clues to understand more of the belief systems of the time.

Figure 1.11: A rock art panel at Onake Kindi, near Hire Benakal, Karnataka

The possibility of cultural continuity from the Neolithic to the age of megalith building has already been discussed in the context of the ashmounds of the south Indian Neolithic. There have been instances of occupation or reoccupation of ashmounds for megalith-building activity and possible re-use of ashmound material in subsequent megalithic constructions. There have been suggestions of possible evolution of subsequent architecture – both sepulchral and otherwise, like Buddhist stupas (Schopen 2010) or Hindu Temples (Kramrisch 1976) based on similarity of form or concept or based on archaeological evidence. Though this is probably more difficult to prove, it offers an opportunity to better understand the evolution of cultural traditions in the subcontinent.

Chapter 2: Origins of Astronomy

2.1 The sky as a cultural resource: Anyone who goes out into the night at a dark site cannot fail to be impressed by the splendour of the night sky. It can be easily imagined how our ancient ancestors would have been awed by the majestic beauty of the heavens at night. From indirect evidence from some of the structures left behind by our ancestors, they seem to have been keen observers of the events played out on the celestial screen (Krupp 1977, 1983, Hadingham 1983). Astronomy has therefore been considered one of the oldest sciences. It is considered science since, like true science, it is impervious to human intervention, is (largely) periodic and hence also observations are verifiable and all theories testable at least as far as classical observational astronomy is considered. Our ancestors could probably relate periodic events on earth, such as the agrarian cycles, to changes in the sky since many important events such as seasons seem to be intimately connected to the skies. Thus, there could have been a practical and useful side to what probably originated in a deep sense of awe for the events that occur in the sky.

The skies above provide rains which seed the earth and hence the image of Mother Earth and Father sky arise very early in human imagination. The skies are also full of magic, of rainbows, thunder, lightening, comets and much much more. It is also a place from where all earth can be seen. Hence the skies (heavens) are a natural place for all gods to reside. Some of the very earliest myths, probably dating back to the Palaeolithic period, were associated with the sky, which seems to have given people their first notion of the divine (Armstrong 2005). This is exemplified by the fact that nearly every pantheon has its Sky God.

Very little is known about the belief systems and knowledge systems that prevailed in prehistoric societies. The little that we know of prehistoric culture is gleaned from the study of the remnants of whatever they left behind, be it implements and utensils or burial complexes, pieces of art in rocks and idols or the mysterious stone constructions that seem to be scattered all over the world or the few sites of pre-historic art that are still preserved today. At best one can form a patchy view of what life and beliefs were like in prehistoric times.

Information on what kind of knowledge these societies possessed would be an important step in the understanding of the intellectual level possessed by their culture. Ancient people possessed a

significant level of knowledge of their surroundings, including astronomical cycles (Baity 1973, Krupp 1977, 1983, Hadingham 1983, Norris 1984). While their attempts to keep track of seasons is in the best traditions of modern observational science, their knowledge system in general can be more closely associated with "culture" as it was probably closely related to religious and ritualistic practices that led to better use of resources and greater understanding of the cosmos.

Understanding the status of knowledge, and hence the intellectual level that existed in these ancient societies could play an important role in comprehending and interpreting the other facets that are known about their culture, such as their burial practices and associated beliefs. While some of the constructions from those ages that still remain and the materials and implements used then tell us a great deal about the state of technology (and knowledge systems) that existed in the period, we do not know much about the kind of time-keeping that used to exist. We know that many of these societies were highly organised and must have possessed fairly sophisticated means of marking time. Information about the level of sophistication of astronomical knowledge that could have existed in a society would provide a great deal of insight into aspects such as their grasp of the nature around them.

Astronomical knowledge possessed by a culture also provides insights about its religious beliefs and practices. Many cultures have associated cosmic power with sites on earth that could have served as "temples" where one communed with the cosmos (Krupp 1997). This is backed by the fact that almost all ancient cultures have their own cosmology and cosmogony that tell their version of how the universe was created. Living traditions among indigenous people of the world can still be found, where such knowledge is handed out in the oral tradition through folklore and songs (Krupp 1997) and social practices. Thus understanding the level of astronomical knowledge possessed by prehistoric societies is crucial for coming closer to a total understanding of their culture.

Reliable evidence from many sites, for instance, Stonehenge in the Salisbury plains of Britain does suggest that at least some prehistoric societies did possess quite an intimate knowledge of the cycles of the Sun and the Moon, and that these were of enough importance to the builders of these structures to undertake such constructions. It is important, however to understand the level of astronomical knowledge and associated cultural beliefs in ancient societies all over the world since this then could be compared with currently accepted views about the places of origin of

such beliefs and practices and their spread across cultures. Such studies help us to get a better grasp over the little-known aspects of world prehistory.

Indeed, it is hard for us to imagine the impact of the night sky of the minds of prehistoric people. In today's cities we are hemmed in by tall buildings, and intense light pollution that makes it impossible for us to see the stars. Even the people of a century ago had more awareness of the sky than we do now. What was it like, then, for the skywatchers of the ancient past, who did not have our knowledge of the physical universe to explain away the stars? To them, the night must have been a source of wonder and mystery. The changing appearances and movements of the sun, moon, stars, and planets formed a complex pattern that demanded understanding. Once mastered, this knowledge of the sky provided a sense of control and predictability over the physical and supernatural realms (Hadingham 1983).

Study of ancient astronomy is therefore not limited to the purely technical matter of how prehistoric observations were carried out. The most interesting question is how the sky-watchers connected their skills with both everyday needs and spiritual impulses. By trying to reconstruct their sky visions, we gain an insight into how people in the distant past regarded themselves as well as the natural surroundings in which they found themselves.

This chapter will discuss the current understanding of the origins of astronomy, including those inferred from studies of prehistoric societies. But initially, before proceeding to that discussion, we highlight some basic concepts of astronomy as observed by the unaided eye.

2.2 Astronomy with unaided eyes: A study of the contributions of several ancient societies, as will be seen in the later sections of this chapter implies that there was a very detailed understanding of the celestial cycles. In spite of the difference in approach to astronomy adopted by different cultures the broad feature of their understanding was universal in its contents. This kind of comprehension can be had only after at least a few centuries of careful observation of the sky and some form of record-keeping. It would also entail the installation of markers of varying size scales, in perishable material or stone that endures to keep track of the motions of the heavenly bodies. The kind of cycles observed in the heavens, as well as a framework for understanding the same, is outlined below.

2.2.1 The celestial sphere: It is convenient for us to imagine the sky as a huge sphere (of infinite radius) with the Earth at its centre. The stars and planets, Sun and Moon can be imagined to be stuck on the inner surface of this celestial sphere (Ridpath 1998, Krupp 1977, Krupp 1983, Smart 1977) (see Fig.2.1). For any observer, only one half of this sphere would be visible at any one time. This celestial sphere rotates around the earth once a day. Now imagine extending the plane of the Earth's equator so that it touches the celestial sphere. It would give us the celestial equator upon intersecting the celestial sphere. Similarly, an extension of the Earth's axis in either direction would give us the celestial North and South Poles. The local celestial meridian at any given location upon the Earth's surface is the great circle passing through both the celestial poles as viewed from that place and through the local zenith.

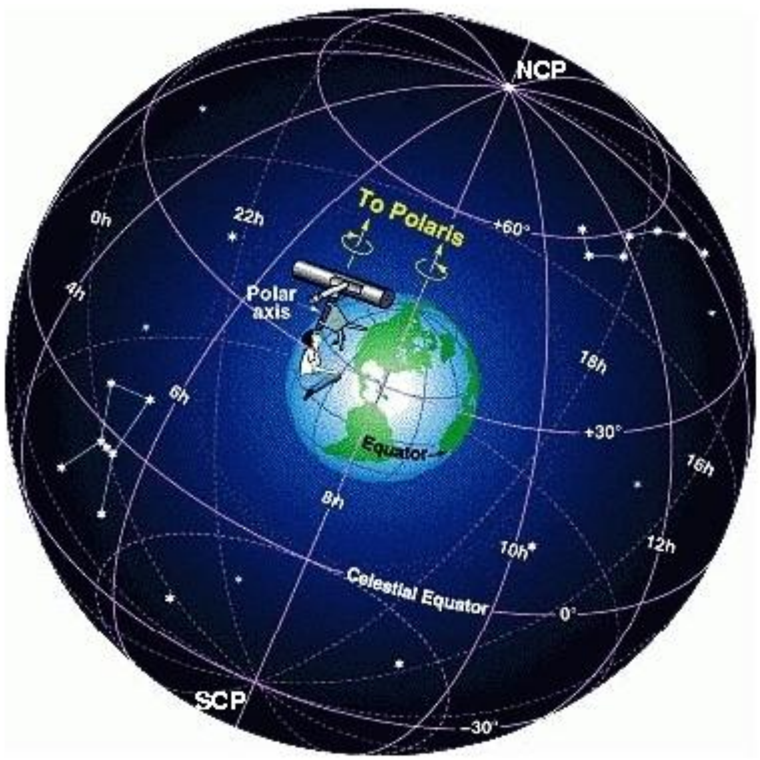


Figure 2.1: The celestial sphere

The Earth revolves around the Sun once in 365 ¼ days – a period of time we call a year. This shows up as an apparent motion of the Sun along the celestial sphere. The Sun traces out a great circle on the celestial sphere over a year, known as the ecliptic. Since the Earth's equator is

inclined to the plane of its orbit by 23 1/2^{o}, the ecliptic is similarly inclined to the celestial equator (see Fig. 2.2). The ecliptic crosses the celestial equator at two points. When the Sun is at these points (i.e. when the Sun is on the celestial equator – which happens twice a year), we have the equinoxes, when the duration of day equals that of night. Midway between the equinoxes, when the Sun is at its farthest point above and below the celestial equator, we have the longest and shortest days of the year – known as the solstices. At present, the spring or vernal equinox falls on the 21 of March and the autumnal equinox on 22 of September, while the summer solstice falls on 21 of June and the winter solstice on 22 December.

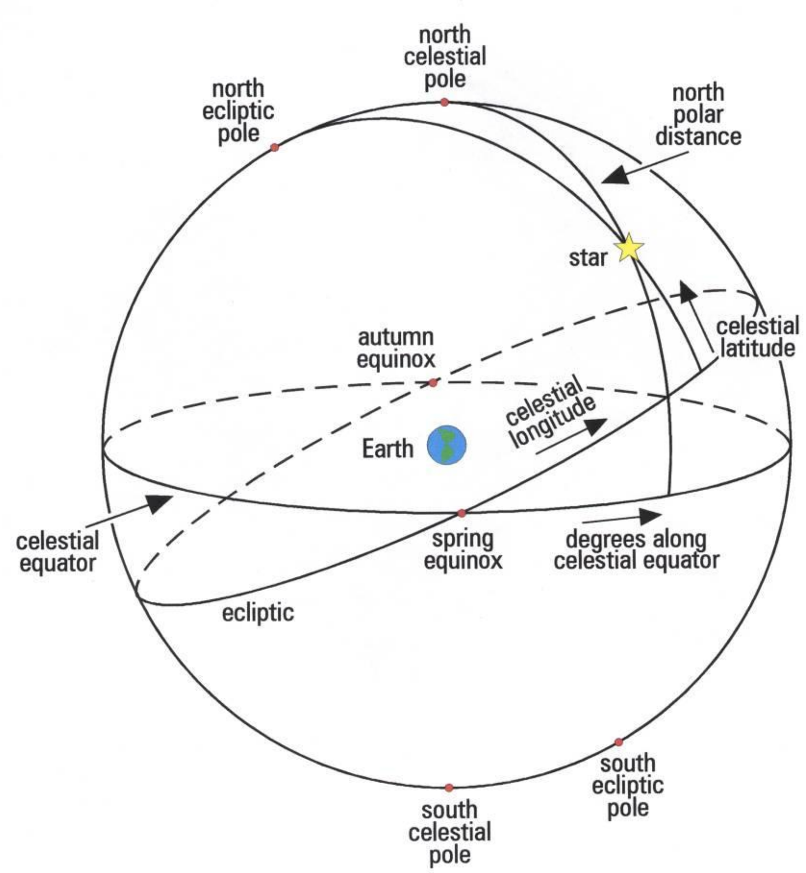


Figure 2.2: Showing the celestial equator, ecliptic and the celestial co-ordinate systems

The simplest co-ordinate system used to describe the positions of heavenly bodies is the equatorial co-ordinate system. This system is similar to the latitude-longitude system used to describe positions on the surface of the earth. The celestial equivalent of terrestrial longitude in this system is the number of degrees along the celestial equator measured eastwards from the vernal equinox. This co-ordinate is called Right Ascension (or RA) and it is commonly measured

in hours, minutes and seconds of time. Since the whole celestial sphere goes around once in 24 hours,

$$1^h \text{ of RA} = 15^o.$$

The celestial equivalent of latitude is called Declination and is measured in degrees, minutes and seconds of arc away from the plane of the celestial equator. Thus the North Celestial Pole has a declination of $+90^o$ and the South Celestial Pole has a declination of -90^o.

2.2.2 The Solar cycle: The simplest way to observe the relation between the heavens and the seasons is to look at the change in daily movement of the shadow over time. A simple tree or preferably a gnomon (essentially a stick erected vertically in the ground) would make a very good season marker. As the Sun moved over the year, the noon shadow for example would become shorter and longer with the exact pattern that is sensitive to the latitude of the place.

A reliable calendar can be obtained by observing the rising (or setting) points of the Sun at any given location on the Earth. The solstices mark the extreme points on the horizon between which the Sun oscillates. Midway are the equinox sunrises (or sunsets), marking cardinal East (or West). In Fig.2.3 we have plotted the situation as it would be seen from a location in the northern hemisphere. An important point to be noted here is that, for a given location, a point on the horizon corresponds to a fixed declination – so when comparing sites with different latitudes, it is best to convert horizon points to declinations.

A calendar was of extreme importance to ancient societies, especially after the advent of agriculture. Due to its relation with the seasonal cycle, its importance and immediate application to agriculture is obvious. Yet the real power of a calendar goes beyond this. It permits a complex organisation of culture. If there are farming surpluses, time becomes available to other people for other activities which in turn enhance the economy of the society. If full-time farming is not required of the society, division of labour is stimulated. And the society grows more complex. All this calls for a precise calendar; one that is in tune with the celestial (and thus terrestrial) cycles.

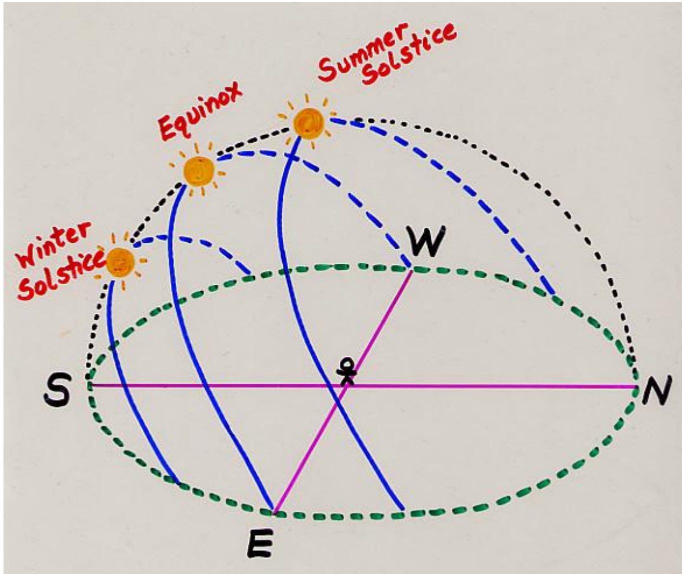


Figure 2.3: Showing diurnal path of the Sun for the equinoxes and solstices for a location North of the equator.

2.2.3 The Lunar cycle: The Sun is not the only celestial body used to calibrate calendars. There are calendars based on the Moon also. Easter is determined using the Moon and the Islamic world still uses a lunar calendar. The Hindu calendar uses the position of the Moon to determine the dates for various festivals with a complex synchronisation with Solar year spread over 4 years using the concept of intercalary month or *Adhik Masa*. The lunar calendar is useful to tell time over shorter period of times of a few hours to days, but it does not stay in step with the seasons or the solar calendar. Of course this is because the cycle of the Sun is not an integral multiple of the cycle of the Moon.

The Moon's motions are significantly more complex than those of the Sun. The Earth revolves around the Sun and the Moon revolves around the Earth. As the Moon moves in its orbit around the Earth its position with respect to the Sun changes. Shining only by the reflected light of the Sun, the Moon alters its appearance. It goes through a series of phases – new moon, crescent, half, gibbous and fill moon (Fig.2.4). The time from full moon to full moon is a lunar cycle or the synodic month, which lasts about 29 ½ days.

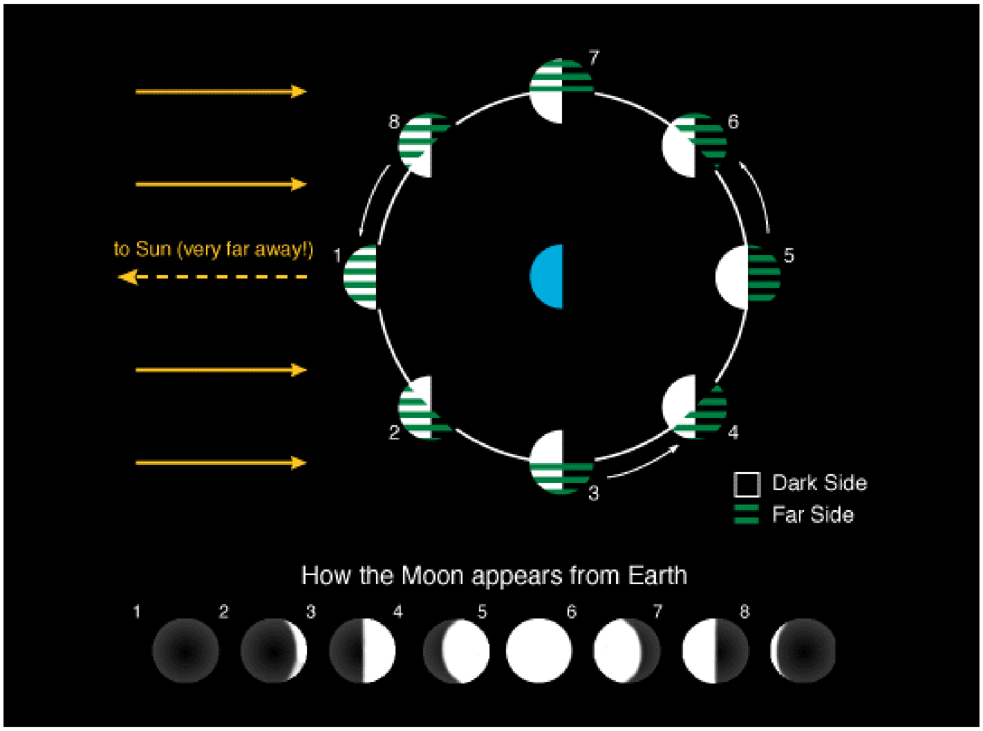


Figure 2.4: The phases of the Moon

Eclipses are caused by the Sun – Earth and Moon coming in a straight line so that either Moon obstructs our view of the Sun (solar eclipse) or the shadow of the Earth falls on the Moon (lunar eclipse). If the Moon's orbit coincided with the plane of the ecliptic, the full moon would rise at the same position at the same time of the year every year. Moreover, there would be a solar eclipse at every full moon! However, the orbit of the Moon is tilted at 5^o to the Earth's orbital plane and hence, to the ecliptic. The situation, however, is further complicated by the fact that the Moon's orbit precesses, or turns with respect to the Earth's orbit.

The points of intersection of the Moon's orbit with the ecliptic are called the nodes of the Moon's orbit. The line connecting the nodes or the "line of nodes" turns over the years. It completes one full circle in 18.61 years. Over this period, the northern moonrise extreme moves from a maximum to a minimum back to a maximum. The maximum extreme is called the major standstill and the minimum extreme is called the minor standstill (see Fig.2.5).

The change in the position of moonrise is accompanied by a change in the "height" at which the Moon crosses in the sky. This is particularly noticeable for the full moon – whose light is important to a culture lacking in electric illumination.

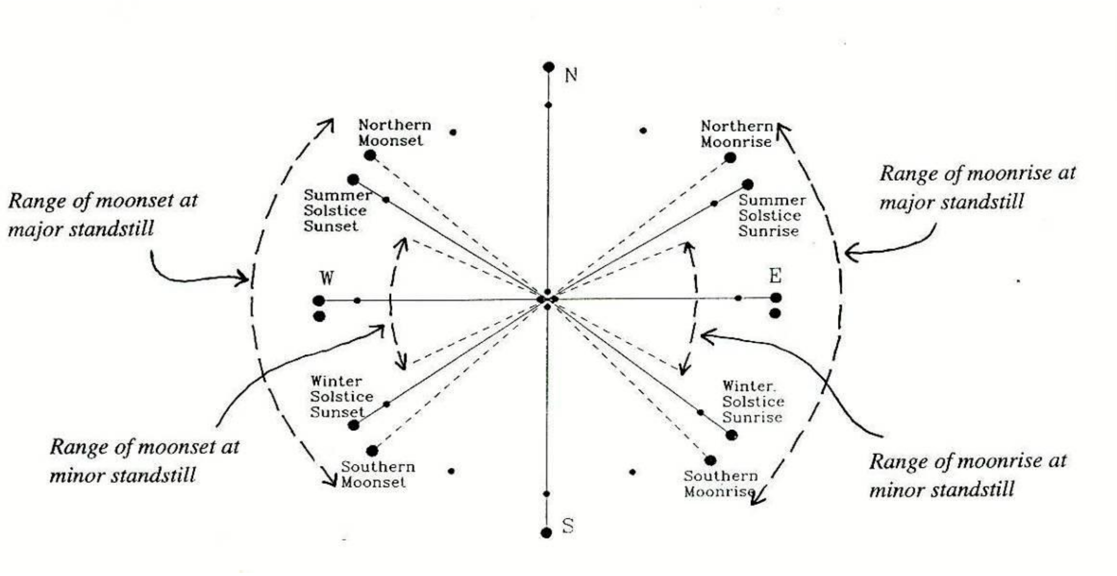


Figure 2.5: Showing markers to points on horizon for the solar and lunar celestial events

2.2.4 Stellar observations: The stars too, arguably, were objects of importance to ancient astronomers. Star groups like the Big Dipper (*Saptarshi*), Pleiades and bright stars like Sirius are known to have occupied places of great importance in ancient astronomies (Krupp 1977). In particular, the phenomenon of heliacal rising of stars was the prime stellar phenomena watched out for. A star is said to rise heliacally when it becomes first visible before sunrise. The heliacal rising of Sirius was extremely important to the Egyptians because it coincided with both the summer solstice and the annual flooding of the Nile – during one period of their history. Since the Nile and the agricultural cycle dominated the then way of life in Egypt, the importance of this event is obvious.

The stars do not seem to move appreciably within several human lifetimes. But the Earth's axis does not always point in the same direction. It wobbles like the axis of a top, and describes one full circle (of radius 23 $1/2^{o}$) once every 28,500 years (Ridpath 1998) (see Fig.2.6). This is called precession. Precession is a westward motion of the equinoxes on the celestial sphere (see Fig. 2.7), due to the gravitational pulls of the Sun, Moon and the planets on Earth. The equinoxes precess by about 50".3 per year or 1^{o} every 71.6 years. Because of precession the RA and Dec of the stars are continually changing. Thus archaeoastronomers have to calculate how the sky appeared to civilizations of a bygone era. No wonder that archaeoastronomy is truly an

interdisciplinary science – one needs the skills of astronomers, archaeologists, architects and ethnographers to investigate the past!

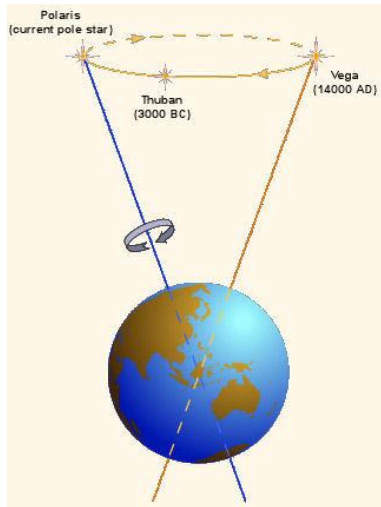


Figure 2.6: Precession of the Earth's axis

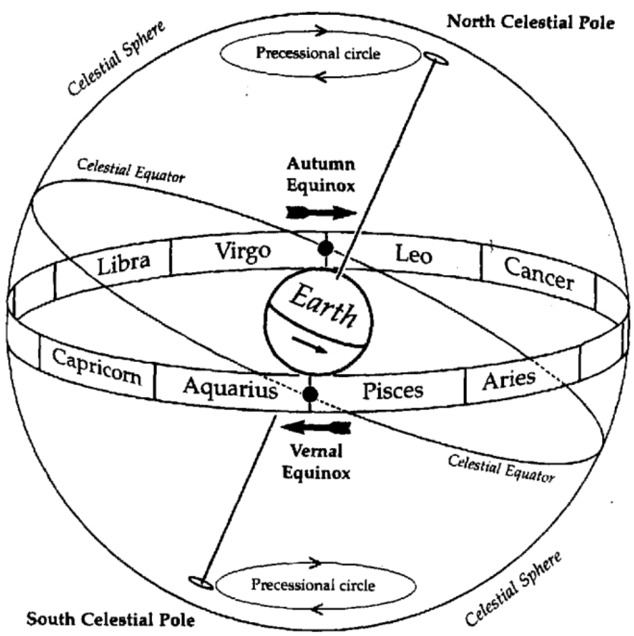


Figure 2.7: Showing the precession of the equinoxes

2.3 Origins of astronomy – the world perspective: A time framework is essential to our daily thoughts and actions. The origins of our present system are ancient, with roots in several different early civilizations. Whenever we tell time by a clock, we are referring to units of time originating in the Babylonian number system based on sixty. To the ancient Egyptians we owe

the invention of a 24-hour day and a 365-day year. The division of the year into its present pattern of weeks and months arises from the efforts of Babylonians, Egyptians, Romans and Hebrews to regulate their affairs. The twelve signs of the zodiac are essentially the same ones invented by the Babylonians over twenty five hundred years ago. All these contributions of ancient sky-watchers to the modern world are so much a part of everyone's experience that we take them for granted (Hadingham 1983).

Much of this was unknown at the beginning of the last century, when the ancient scripts of Mesopotamia and Egypt not being deciphered. The first breakthrough in the deciphering of an ancient script was the interpretation of the Rosetta Stone (Fig.2.8), which had been discovered by French officers during Napoleon's campaign in Egypt in 1799. The smooth black basalt stone bore three inscriptions, one above the other, each one identical except that it was composed in a different script. One inscription was in Greek, and it helped scholars move forward in translating the Egyptian demotic and hieroglyphic texts also present on the stone (Hadingham 1983). By 1860 cuneiform writing had also been deciphered, and the three ancient languages expressed by the script could be interpreted. These developments unlocked the vast amount of astronomical inscriptions that were accumulated, created by Egyptian, Babylonian and Assyrian scribes.

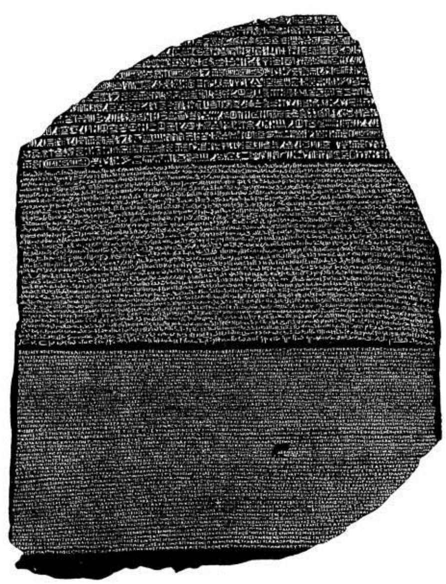


Figure 2.8: The Rosetta Stone which helped the deciphering of two ancient scripts that later enabled the recognition of Egyptian astronomical observing records

2.3.1 Astronomy in Babylon: The city of Babylon lay on the left bank of the Euphrates River, some 70 miles south of modern Baghdad. During what is known as the Old Babylonian period (possibly 1830-1531 BC), the city was ruled by the dynasty of Hammurabi (Hoskin 1997). There is evidence for regular astronomical observations from this period. The system adopted seems to have been to compile huge lists of eclipses, lunar phases and planetary movements over many centuries so that later astronomers could consult the lists to search for regular patterns among the timings of these events. The number patterns that resulted from the search were then projected into the future. As far as we know, there was no attempt to visualise the sky events in terms of orbits or any other geometrical concepts (Hadingham 1983).

Though we still encounter the Babylonian influence of 60 minutes in an hour and 360 degrees in a circle in our everyday lives, thanks to the adoption of these by later Greek astronomers, the Babylonians had a complicated calendar – needing the insertion of an extra months every two or three years. Our calendar we owe to the example of the Egyptians.

2.3.2 Egyptian astronomy: For calendrical purposes, what was needed was a framework that did not rely on the awkward rhythm of the waxing and waning moon. A smoothly functioning calendar required that one conceive of the year as a fixed length of time, divided into artificial months of equal length regardless of the actual appearance of the moon. The Egyptians hit upon such a solution as far back as the 3rd millennium BC. They divided the year into 12 months of 30 days each and added an extra 5 days at the end of the year to bring up the total to 365, although they persisted in following more complicated lunar calendars for the timing of their religious festivals.

The second legacy of the Egyptians is the 24-hour day. Their observers waited for the rising of particular stars to mark passage of time. There were 36 of these special timekeeping stars, known as decans, used to subdivide the calendar into 10-day periods (Hadingham 1983).

Besides these advances in practical time measurement, the Egyptians also left behind an enduring symbol of ancient knowledge – the Great Pyramid. Like Stonehenge, it has inspired endless theories about its astronomical and mystical functions, often of a fantastic nature. A rational appraisal of the evidence suggests that only the most rudimentary astronomical knowledge is incorporated in the Great Pyramid. The four sides of the base, each about 756 feet

long, line up with the four cardinal directions. The greatest error in the orientation is little more than one-twelfth of a degree. It is astonishing that the pyramid builders managed to maintain such accuracy as they manhandled more than 2 million limestone blocks – each weighing an average of more than 2 tonnes. There was no Pole Star shining due north in the heavens as there is today (see the previous section on precession). The observers must have marked the rising and setting points of a star in the northern sky and halved the angle between these points to arrive at their north line (Hadingham 1983).

2.3.3 Greek astronomy: The Greeks are credited with arriving at an early form of the Scientific Method adopted by modern science, though they drew heavily from the Babylonians before them. The Greeks used geometric models of the movement of planets in an effort to represent their observed positions at all times, as against the Babylonians who used arithmetic to investigate special configurations of heavenly bodies (Hoskin 1997). The achievements of Pythagoras, Aristotle, Plato, Aristarchus, Hipparchus and Eratosthenes are too well known to be recounted in this brief summary of ancient world astronomies. Ptolemy's *Almagest* was an influential textbook of its time (127-141 AD, judging by the observations he reports). It is a magisterial work, providing geometrical models and related tables by which the movements of the Sun, the Moon and the five lesser planets could be calculated for the indefinite future. It also contained a catalogue of over a thousand stars arranged in 48 constellations, with the longitude, latitude and apparent brightness of each. Though essentially flawed in subscribing to a geocentric model of the solar system, few if any mathematical works of comparable quality would be written after Ptolemy's time, making his work a masterpiece for its times.

2.3.4 Prehistoric astronomy in the world: The above sections dealt briefly with some of the main civilizations that contributed to the growth of modern astronomy, though a few important cultures like those of South America etc. have not been dealt with, due to paucity of space for discussion. We now turn to earlier periods – before the advent of written records. There have been speculations and conjectures that many of the early structures left behind by prehistoric man – especially in the European Neolithic were laid out to astronomical layouts. Some of these will be discussed below.

Scattered all over the world one comes across curious monuments in stone constructed by unknown builders from mankind's prehistoric past. Some of these are associated with burials,

but many are just plain riddles in stone with their purpose remaining obscure. Many of them were found to have alignments towards directions of astronomical significance by research workers like Alexander Thom (Thom 1967). For instance, Stonehenge (Fig.2.9) was shown to have alignments pointing towards solstice and equinox sunrise and sunset points on the horizon. Interpretations attributing more sophisticated astronomical purposes to this composite structure (believed to have been built in phases over 3000BCE – 1500BCE), such as eclipse prediction, have been put forward by Hawkins (1963, 1964, 1965, 1966), Hoyle (1977) and Thom, Thom and Thom (1974, 1975) have suggested that the monument may have been a lunar observatory.

Figure 2.9: Stonehenge - astronomical observatory or ritual monument?

While Stonehenge was attracting popular attention (and controversy) in the 1960's, Alexander Thom (1894-1985), a retired Oxford professor of engineering was quietly continuing the mammoth task he had set himself, of surveying to professional standards the many hundreds of stone rings and other megalithic monuments mentioned in the last paragraph (Hoskin 1997). Thom maintained, based on his surveys not only that these megalithic monuments were constructed according to complex geometrical designs and laid out using carefully determined units of measurement, but that they were precisely located in order to facilitate astronomical observations of great accuracy. Thom's sites have since been re-examined under procedures

carefully designed to ensure objectivity. The controversy continues, but the re-examination has greatly reduced the plausibility of his claims to have demonstrated the existence in prehistoric Britain of predictive astronomy (Hoskin 1997, Heggie 1981). Yet the true value of Thom's work endures: today, prehistorians everywhere work with an increased awareness of the sky as a cultural resource for the people they are investigating.

We do not know for sure if these structures were built to observe the motions of celestial bodies, but from the alignments that have been demonstrated to have clearly an astronomical basis and not just chance alignments, it is clear that their builders did possess an intimate knowledge about the motions of the Sun, Moon and planets in the sky. It is possible that the earliest of these "observatories" could have been wooden posts erected as fore and back-sights to important events on the horizon, but it is likely that stone was increasingly preferred to make more permanent structures. Woodhenge, 3 km north-east of Stonehenge, is an example of a wooden structure that used to exist, survived now by holes in the ground that used to house the posts (Osborne 1995). The large number of stone monuments and the considerable effort that would have gone into the erecting of these, point to the importance that the builders would have accorded to the monuments and the purpose they served.

It is to be stressed that, even if deliberate orientations to astronomically significant directions can be established, these might have had some "ritual, superstitious or religious purpose" and not "some other practical or scientific purpose" as we might be tempted to conclude (Heggie 1981). Heggie also states that megalithic astronomy might have been practical – as for calendar-keeping by agrarian societies, or religious, even political – as to strengthen the grip of some ruling elite by the prediction of spectacular phenomena like eclipses, or even just out of curiosity. He reminds us about "the complex links, even at the present day, between orientation, religion, ritual and burial practices."

It is a curious fact that most of the monuments that one finds the world over fall into a few categories and the similarities that one finds in monuments separated by thousands of kilometres and sometimes on different continents are striking. The cultural trait of megalith-building is supposed to have originated somewhere in Oman from where it spread to Europe, Middle-East and India through the sea route (Mathpal 1998), though most modern researchers discount the diffusion theory. It is conjectured that the tradition of Megalith age began from Neolithic times

and continued in the Bronze Age and up to the late Iron Age. In fact, many tribes, including some in India, still have a living tradition of Megalithic period to mark burials (Sundara 1975).

2.4 Ancient Indian astronomy: Whenever there is a discussion of Indian science, there is a tendency to confuse myths and epics with actual scientific treatises by laypersons (Narlikar 2003). Narlikar argues that one should not get carried away by myths, howsoever exciting and absorbing they may be. Ancient Greece also had epics like the *Iliad* and the *Odyssey*, but it also has evidence in the writings of Euclid, Pythagoras and Archimides, work which is scientifically much more interesting but otherwise much more mundane than the adventures of Theseus, Achilles or Ulysses.

In the case of India, too there have been truly original ancient contributions to both the pure and applied aspects of science, as established from well-documented evidence (e.g. Burgess 1860). For a broad summary see Vahia, Menon, Abbas and Yadav, 2011.

2.4.1 Milestones in early Indian astronomy: The *Shulva Sutra*, which belongs to the literature of the Vedic times (c.1500-c.200 BC), has a title that means rules of measurement. The origins of the sutras can be traced to the Vedas, and they have been known at least eight to nine centuries BC. The *Shulva Sutra* contains, for example, Pythagoras' theorem, but not the proof of the theorem, as Euclid's *Elements* does. Also, it gives an approximation of $\sqrt{2}$ but without explicit proof. The discovery acknowledged and ascribed to the Vedic period most commonly today is that of the zero and the decimal system of writing numbers.

Of the six parts of the Vedas (*Sad-vedangas*), the sixth, *Vedanga Kalpa*, contains the *Shulva Sutra*. The fifth *Vedanga*, the *Vedanga Jyotisha*, is the earliest known astronomical text from India. It is generally ascribed to the sage Lagadha. Astronomy provides us a method to date this text, namely the precession of the equinoxes (see chapter 3). The text prepared at the time of Lagadha records that the winter solstice was at the beginning of the constellation Shravishtha (Delphini), that is the Sun was in that constellation on the shortest day of the year. Likewise the summer solstice was in the mid-point of the constellation of Ashlesha. Now Varahamihira, who came much later (c. AD 530), has stated that in his time the summer solstice was at the end of three quarters of Punarvasu and the winter solstice was at the end of the first quarter of Uttarashadha. Thus since Lagadha's time there has been a shift or precession of approximately

$23^{o}20'$ in angle. A one degree shift takes approximately 72 years, a shift of this amount will take 1680 years. That would put Lagadha's time and the *Vedanga Jyotisha* at around 1150 BC. Allowing for the uncertainties of interpretation, the date may be placed somewhere between the 14th to 12th century BC.

While this much can be put together from ancient texts, not much has been understood about astronomy in prehistoric times in the Indian subcontinent. It is inconceivable that a civilisation of the cultural complexity and technical ingenuity of the Harappan Civilisation were not conversant with observational astronomy. But not much headway has been made in the astronomy of these contemporaries of ancient Mesopotamia.

2.4.2 Indian prehistoric astronomy: Many researchers have studied the orientations and alignments of megalithic monuments in Europe, the Mediterranean region etc. (Belmonte 2005, for details) However, a systematic study of the possibility of astronomical alignments for Indian megaliths has not been carried out so far. It is therefore important to examine the rich wealth of megalithic structures that dot our country from this angle. This would help us compare the status of astronomical knowledge and intentions of the megalith-builders of different parts of the world.

Kameswara Rao (2005) sums up possible astronomical aspects of cultural remains from prehistoric India, but the discussion of possible constellations inferred from rock art, earliest possible instruments used for astronomy – such as water clocks etc., the brick platforms of Harappa as gnomon bases and hypotheses about Neolithic and Megalithic observational astronomy remain highly conjectural at best. The site layout inferred by Rao for the megalithic site of Hanamsagar (Fig.2.10) in his 2005 paper is erroneous both with respect to the extent and layout of the monument, thereby making all conclusions erroneous. Rao (1993) discusses possible astronomical orientations of the megaliths of Brahmagiri, Karnataka, but a visit to the site in the course of this investigation and a detailed study of the paper revealed erroneous conclusions based purely on the published data of Wheeler (1948) and not on field survey data of the author (Rao). Also some of the highly dubious sightlines from boulders of one stone circle megalith to those of others do not follow statistically acceptable criteria to form baselines. Also, the revised date of the monuments of Brahmagiri from Morrison (2005) could affect the stellar sightlines proposed by Rao. Rao and Thakur (2010) attributed astronomical purpose to the stone alignment at Vibhutihalli, Karnataka. In this case, too, though the authors have resorted to on-site

measurements, they are confined to observing alignment of a few rows to the solstices and equinoxes. In the absence of a thorough survey of the monument delineating its extent and positions of individual stones, conclusions about astronomical purpose are baseless.

Figure 2.10: A portion of the stone alignment at Hanamsagar, viewed from the west

Vahia and Menon (2012) make a case for the first ever known Harappan structure to be used as a solar observatory at the Harappan city of Dholavira in Kachchh, Gujarat. The remains of a structure in the bailey part of the city has been interpreted by the authors as a solar observatory based on the dimensional response of two circular rooms in the structure to local solar geometry (Fig.2.11). However, the excavator of the site, R. S. Bisht, assigns this structure to the post-urban (non-Harappan) later phase of the site (Bisht 1999, 2000); the authors' stand therefore needs to be tested by a careful stratigraphical analysis of the two circular structures. Should they indeed belong to a later stage, the proposed thesis would be challenged, though by no means ruled out, since Bisht (*Pers. Comm.*) feels that it is quite possible that the later Harappans could have re-used parts of earlier structures and incorporated them in their "observatory".

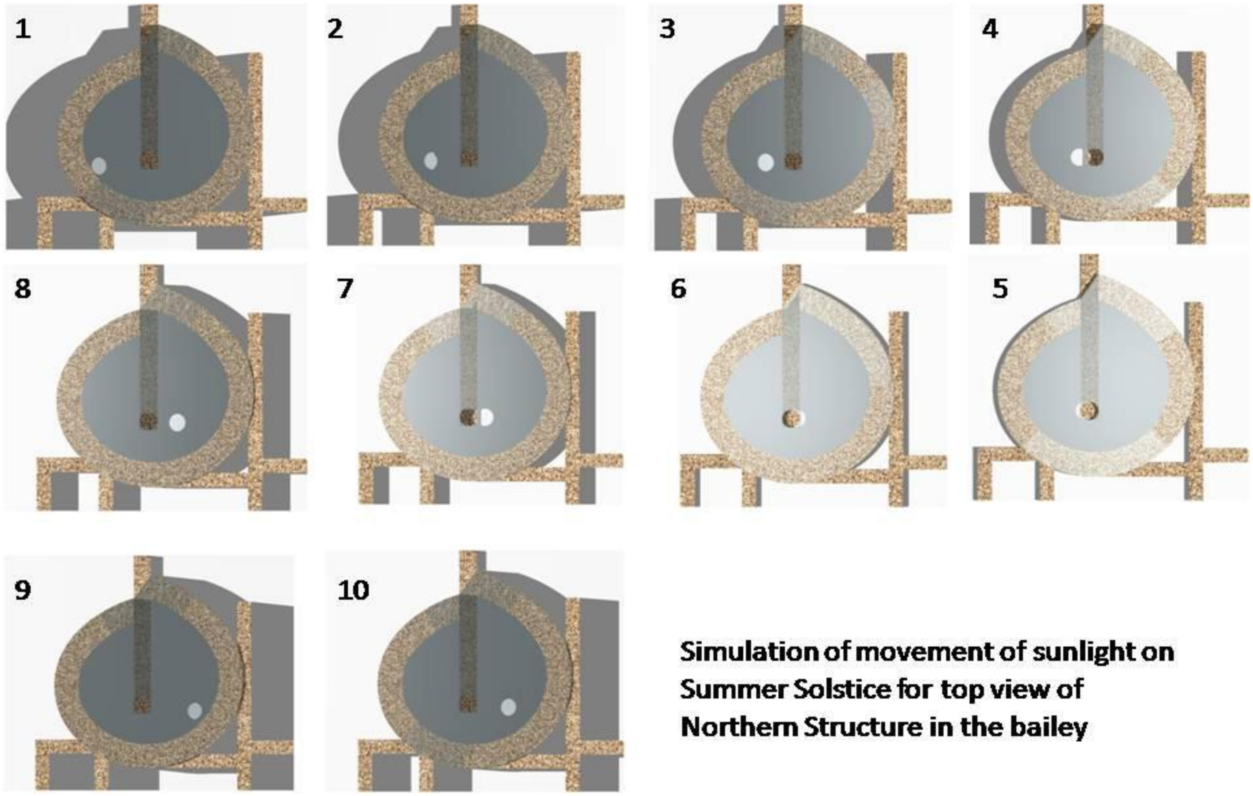


Figure 2.11: Simulation studies for one part of the structure claimed as a Harappan observatory (Vahia and Menon 2012)

During the course of this doctoral investigation, we have come up with interesting results (Menon and Vahia 2010, 2011; Menon, Vahia and Rao 2011, 2012a, 2012b) that will be discussed in the chapters on study areas and methods and results.

2.4.3 The issues of orienting markers: Very little remains of the residences and habitations of the megalith builders. This is one of the reasons why deciphering aspects of their culture has proved difficult. However, if these ancient cultures practised astronomy and made astronomical observations, it is very likely that they would have constructed structures that were durable and stone is likely to be the obvious choice. Such constructions were taken to the limit of technological feasibility in monuments such as Stonehenge, where stones of considerable dimensions were transported from as far as 385 km away to the site. Since it is clear from the effort invested and the obvious importance of the megalithic monuments to their builders, it is interesting to investigate them for connections with astronomy.

From the studies by Alexander Thom (Thom 1967) and others (Hoskin 2001, Ruggles 1999, Heggie 1981), it has been long recognised that many megalithic sites contain indicators marking rising or setting points of the Sun at solstices. It is also quite certain that other equally-spaced dates throughout the year are indicated at many sites. Some sites point to the possibility that the Moon was also carefully observed and some of the brightest stars may have been recorded.

Stone structures are usually stone circles, stone alignments or combinations of these with outliers. Just how they are positioned and the distance they are placed at will depend upon what they are meant to point to. For instance, the stones placed to point to the different positions of sunrise or sunset will have a longer alignment than an azimuthal indicator for a star, which has to be near enough to be seen in starlight. The height of the pole star indicator should also be such that the pole star is visible just over the edge of the stones. Sometimes even single stones can be used as a solitary marker and some prominent feature on the horizon might serve as a natural backdrop. Hence, a potential ancient observatory can have a variety of forms. We will try to explore the possible evolution of a simple observatory below. However, they will all have certain underlying features.

Due to the 23 1/2^{o} inclination of Earth's rotation axis to its axis of revolution, the Sunrise point appears to move north and south of east over a year. During the two occasions in the year when the Sun is on the celestial equator, we witness the equinoxes, when it rises due cardinal east and the length of the day equals the length of the night. Also, the position of sunrise furthest away from cardinal east occurs during the two solstices – when the Sun is farthest away from the celestial equator. The longest day in the northern hemisphere is the summer solstice when the Sun rises at its furthest point north of east. Similarly, the shortest day in the northern hemisphere occurs on the winter solstice, when the Sun rises at its furthest point south of east. The spring or vernal equinox falls on March 21 currently and the autumnal equinox falls on September 23rd. The summer solstice falls on June 21 and winter solstice occurs on December 21.

Hence determining the distance of the Sun from the equinox (or the farthest Solstice) points is critical to predicting the seasons. The best way of determining this is to mark a central point with respect to which the points on horizon are marked to indicate the location at which the Sun rises over the year (Fig.2.12). All figures below are courtesy Hrishikesh Joglekar.

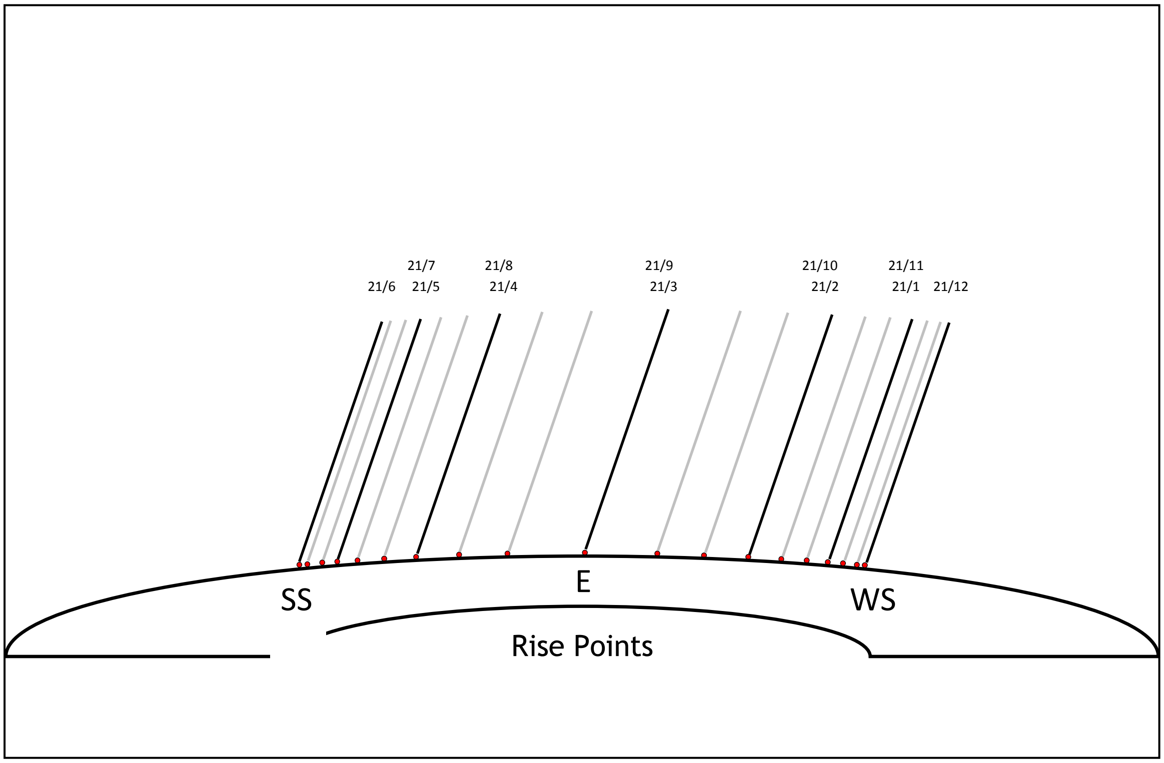


Figure 2.12: Change in the Sunrise point over 1 year from Winter Solstice to Summer Solstice (Courtesy: Hrishikesh Joglekar)

How far north and south of east the Sun rises on the solstice days or how much is the maximum amount of variation in the point of sunrise in a year depends upon the latitude of the place under consideration. The angular spread of these extreme points of sunrise is given by:

$$\alpha = 2 \times 23.5/\cos\varphi$$

where φ= latitude of the place

In Fig. 2.13 we give the major points on horizon for an observatory on the Equator. Now consider the layout of a stone circle for solar observations. From the centre of the circle, where the observer would be stationed, one could lay out two stone uprights to mark the extreme points of sunrise on the horizon. That would be a very simple observatory. The diameter of the circle would depend on the accuracy desired for the observations.

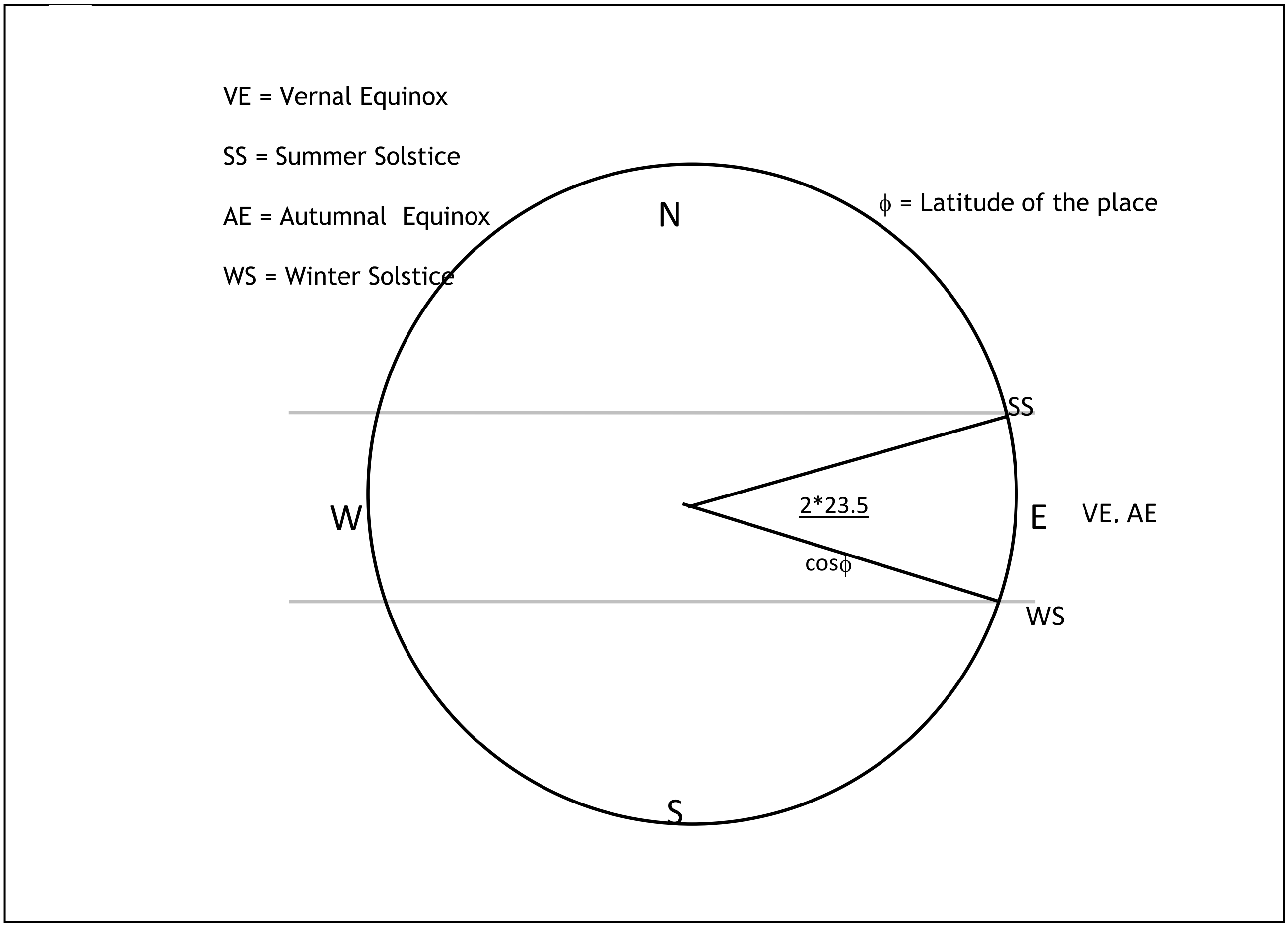


Figure 2.13: Showing the angular spread of the variation of sunrise point along the horizon. For simplicity, the observer is assumed to be at the equator (Courtesy: Hrishikesh Joglekar)

In order to increase the accuracy of observations, the circle can be divided into smaller intervals. We assume that these are equivalent to months (if this not true, it will only change the number of objects in the figure). We therefore divide the year into an equal number of “months” and mark the points of sunrise for equal intervals throughout the year. This is done by drawing an internal circle. The inner circle is divided into 12 equal sectors (Fig.2.14). Stones (or other markers) can be used to mark these points on the circumference of this circle and the Sun rise point on a particular day of a month would be along the line defined by two appropriate stones. These when projected on to the outer circle will indicate the sunrise points for the different months of the year (Fig. 2.15). Of course it can be seen that the rate of progress of the sunrise point along the horizon is faster near the equinoxes and slowest near the solstice points. One can use combinations of stones at these points indicated in the diagram as markers for year-round solar observations.

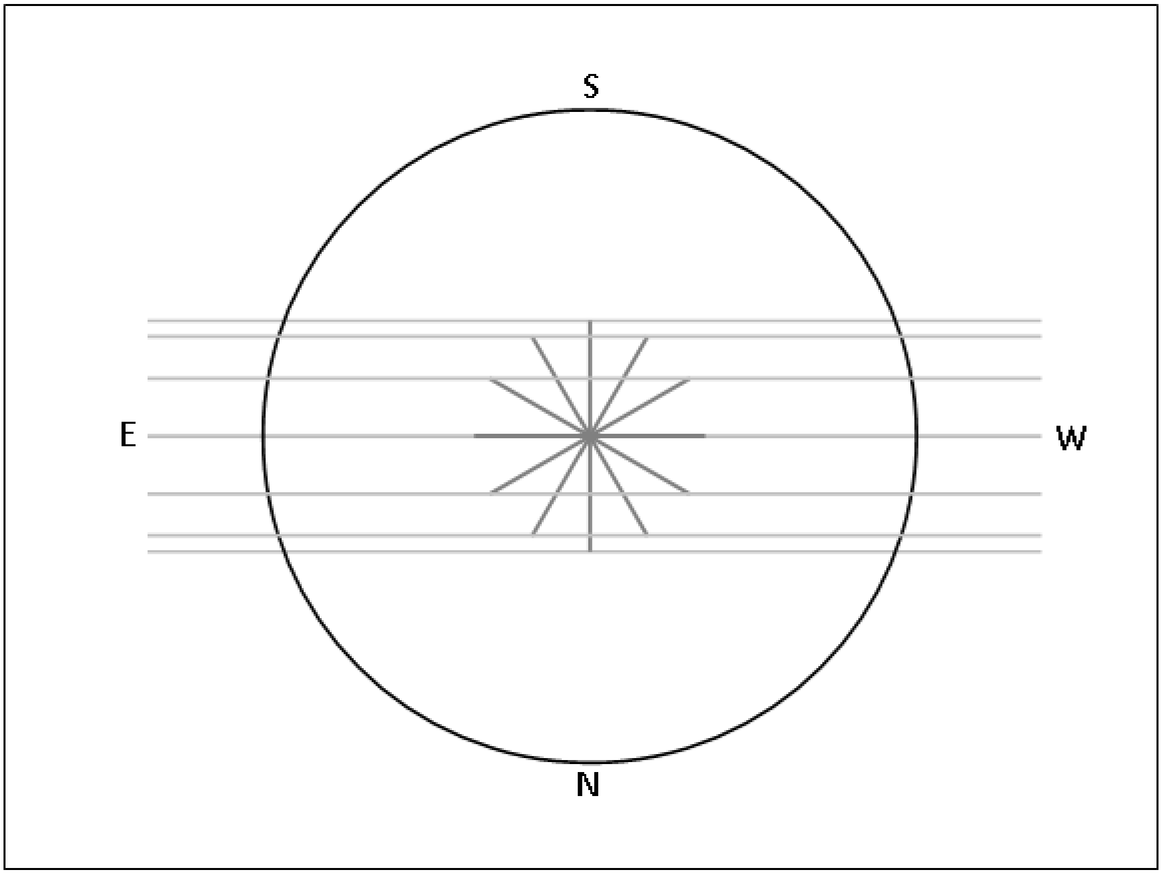


Figure 2.14: Showing division of the variation of sunrise point along the horizon into equal "months" (Courtesy: Hrishikesh Joglekar)

(It is interesting to mention a rather advanced innovation attributed to the builders of Stonehenge. It is well-known that the progress of the sunrise point being very slow near the solstice point, it is difficult to observe the extreme point of sunrise with accuracy. So the builders of Stonehenge have placed the outliers marking the solstices deliberately inside the solstice sightlines so that they observe the sun along this line on its journey to and from the solstices and infer the date of the solstice as midway between those two dates.)

In the final form of the observatory will appear as given in Figs. 2.16 or 2.17 depending on whether the stones are arranged in a circular or linear pattern. Such templates should provide valuable markers towards validating the conjectures.

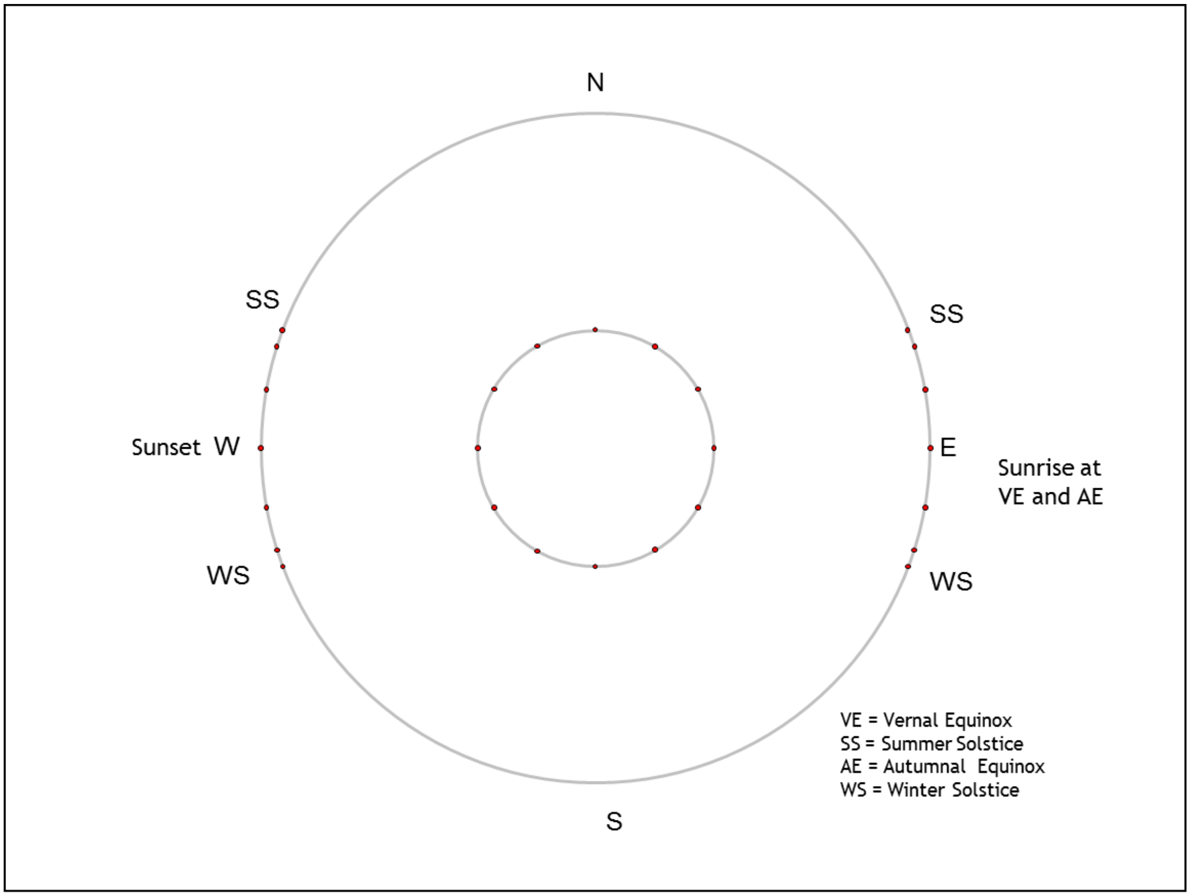


Figure 2.15: Marking of stone patterns in an observatory (Courtesy: Hrishikesh Joglekar)

If the culture is not comfortable with complex geometries of circles and their interrelation or to subtle errors, the observatories can also be made in square format as shown in Fig.2.17. In the figure we have also indicated some additional markers which can be added to circular observatories also.

Any sightline for solar observation thus necessarily falls between the extremes indicated by the equation given above. Similarly, one can work out the maximum spread for the rising and setting points of the moon. It is obvious that any line that falls outside this spread should have a stellar explanation. It can generally be assumed that only first magnitude stars can be included in such conjectures since stars of lower brightness cannot be observed near the horizon.

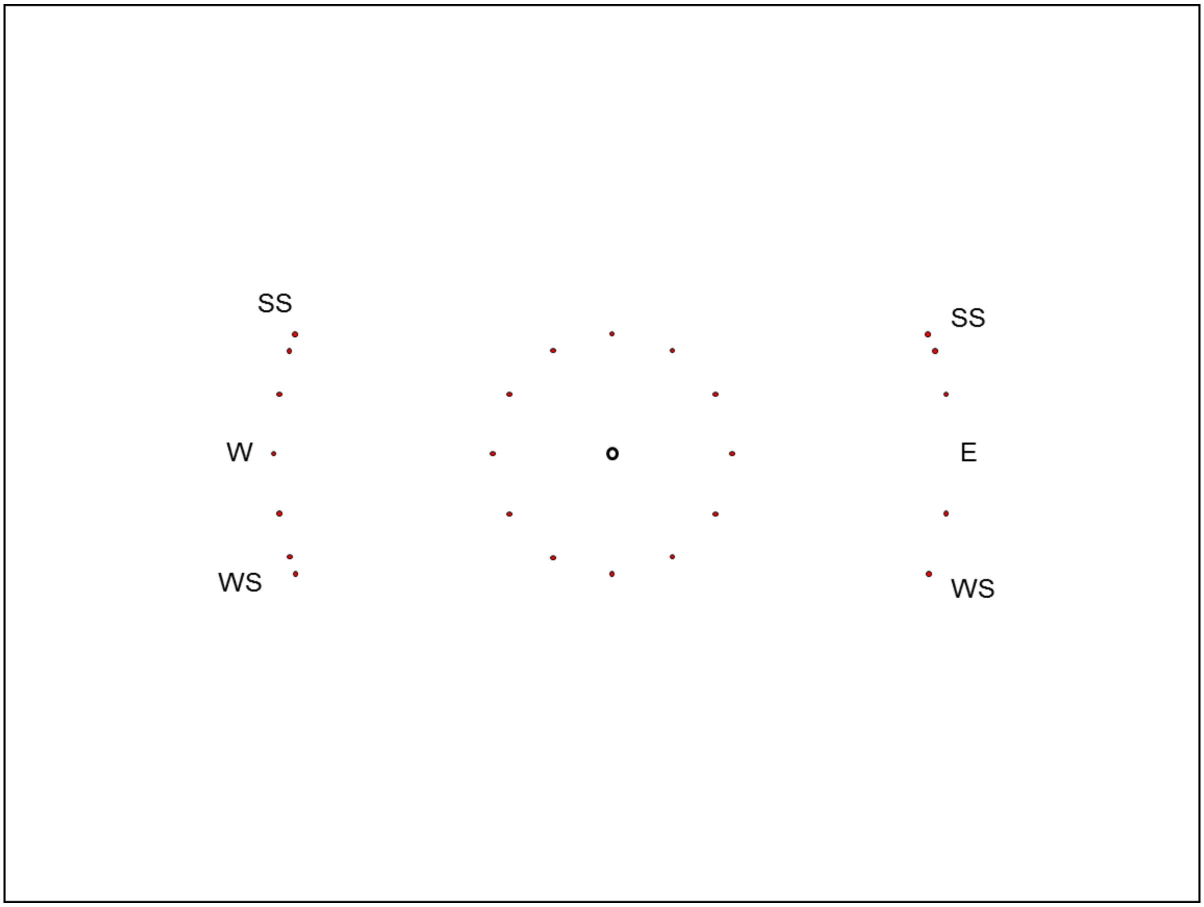


Figure 2.16: Stone markings in a circularly made observatory. Additional stones can be used to mark north and south directions also (Courtesy: Hrishikesh Joglekar)

However, one must exercise caution while conjecturing about stellar orientations, because due to precession one would be able to fit some bright star or another to an orientation given the date ranges given by archaeology (Ruggles, C. *Pers. Comm.*).

A possible 3-dimensional layout of markers (stone or otherwise) of a hybrid (square as well as circular arrangement of markers) is shown in Fig. 2.18.

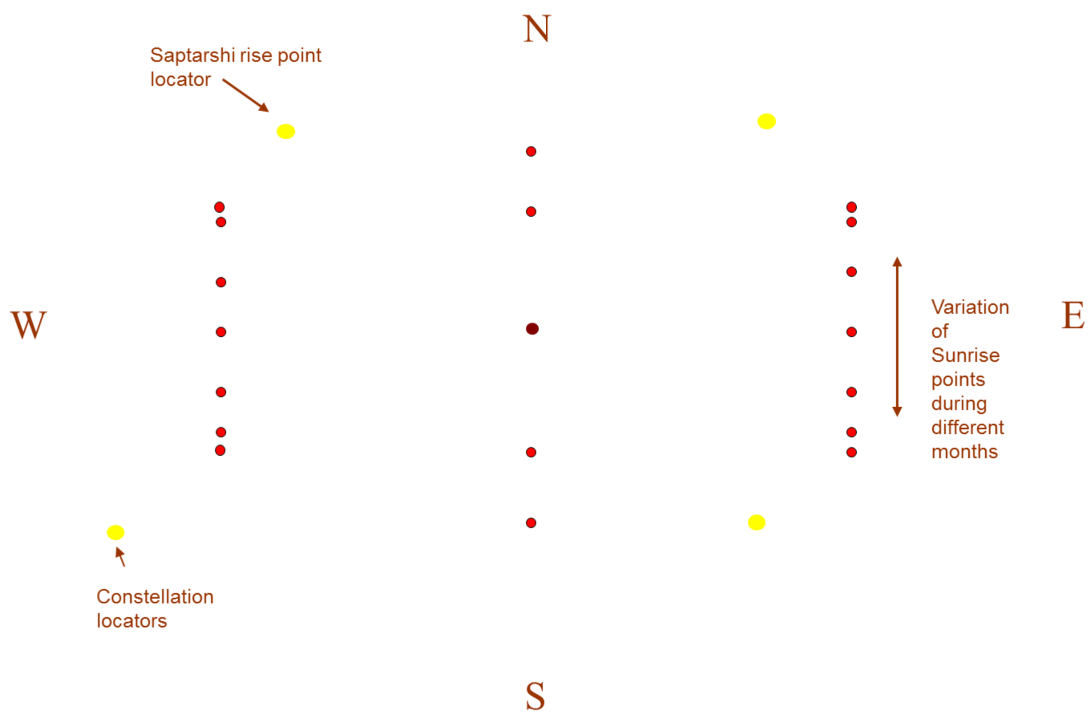


Figure 2.17: Square structure observatory (Courtesy: Hrishikesh Joglekar)

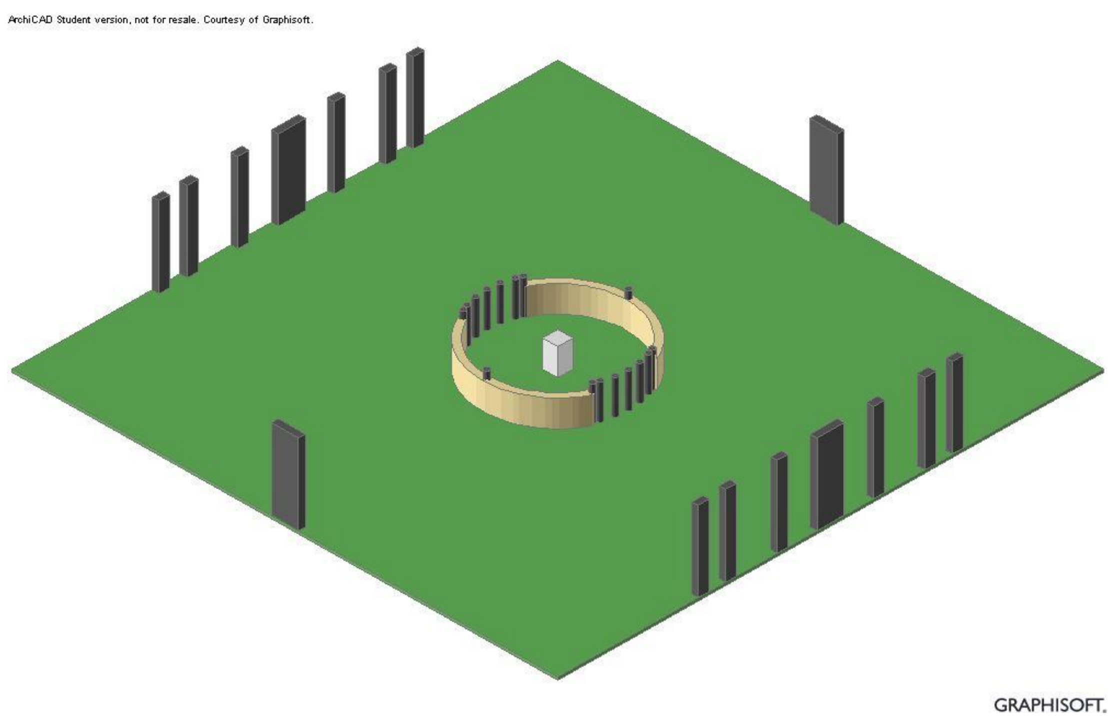


Figure 2.18: Possible structure of markers for a solar observatory structure

Summing up, it is quite possible that early humans would have constructed structures for observing celestial cycles related to the movements of the Sun, Moon as well as the bright stars and maybe planets, too. From the point of view of necessity, these are likely to have been large in scale to permit more accuracy in measurement of the positions of the celestial bodies. Though it is very likely that the earliest such "observatories" might have been constructed out of wooden markers that do not survive, it is expected that at least a few such constructions could be of more durable material, say, stone. The possible forms that such early "observatories" could assume are quite varied, depending on the heavenly body being observed and the mode of observation. For instance, the implied solar observatory at the Harappan site of Dholavira is believed to have employed observations of a patch of light cast by a hole in the roof during meridian transit of the Sun, whereas monuments like Stonehenge observed the position of the Sun (and possibly, the Moon) during rising and setting, quite close to the local horizon. The megalithic typologies termed "stone alignments" or "avenues" are prime candidates to be tested for possible relationship with astronomy, though previous studies of these are not conclusive.

It is also to be emphasized that the orientation of sepulchral megaliths or megalithic graves can also speak of the astronomical knowledge of their builders, though they are obviously not of the class of astronomical "observatories" discussed above. For instance, a consistent orientational preference to any of the cardinal directions implies knowledge of determining the directions among the builders.

In conclusion, it is best to have an open approach to the study of prehistoric monuments for possible deliberate astronomical orientations since the forms that a possible observatory could assume are quite varied depending on the mode of observation that could have been employed.

Chapter 3: Megaliths and Astronomy

In this chapter we discuss the variability in the design and form of megaliths, especially those found in the Indian subcontinent and their possible relationship with astronomy. The megalithic structures have a large variation in style and form. However, underlying this variation there seems to be a common theme in the megaliths spread over a large geographical and time space. For instance, the British Isles have a large range of megalithic monuments like the chambered tomb, stone circle, short stone row, double stone row etc. (Ruggles 1999), some of which find an echo in the context of the Indian subcontinent, too. However, there are also typically endemic forms like the recumbent stone circle, four poster etc. which are characteristic of prehistoric Britain and are found nowhere else. Throughout the range where prehistoric stone monuments have been found, they have been known by different names such as cromlechs, kistvaens, dolmens, cairns (Meadows-Taylor 1941) etc. Taking into consideration similarities in form and design as well as the purpose for which they were built, it is prudent to classify megaliths into broad typologies.

3.1 Indian megaliths – classification and architecture: As discussed above, at first glance, the sheer variety in form that one comes across while studying megaliths can be quite bewildering, in the Indian context, too. Initial attempts at bringing order to this veritable zoo of megalithic monuments led to their classification into pit burials, urn and sarcophagi burials, rock-cut chamber burials, cist burials and stone alignments. To this list were added some more types like dolmen, menhirs etc. and the *topikal*, *kudaikal* etc. which were endemic to certain regions.

However, in general, the construction methods and the nature of the tomb, the megalithic structures can be grouped into two broad categories. Most of these megalithic monuments can be classified into *Sepulchral* or *Non-Sepulchral* (Moorti 1994,). Sepulchral monuments are those which contain (or contained) the physical remains of dead human beings and non-sepulchral are those which were ceremonial or memorial in nature. The former are usually pit or chamber burials with a variety of surface markers of stone whereas the latter are usually dolmens or stone avenue sites which are a grid-like arrangement of several stones.

The sepulchral group of megaliths is clearly intended as the final resting place of the deceased while the purposes for which the non-sepulchral monuments were erected are not clear – they can be either ritualistic, commemorative or may have had other purposes that are not clear today. For instance the dolmen might be a commemorative ancestral shrine, while the purpose of erection of the stone-avenue or alignment might be more difficult to guess. There is some evidence, including the results of this investigation, suggesting that the purposes of at least some of these were astronomical in nature – calendar devices for instance.

This system of classification maybe further elaborated as follows (Moorti 2008):

Table 1 Types of sepulchral and nonsepulchral Megalithic monuments in South Asia

Sepulchral	
1. *Pit burials*	
1a	Pit burial enclosed by an earthen mound
1b	Pit burial enclosed by cairn packing
1c	Pit burial enclosed by boulder circle(s)
1d	Pit burial enclosed by cairn packing and bound by boulder circle(s)
1e	Pit burial capped by a slab and enclosed by boulder circle(s)
1f	Pit burial enclosed by boulder circle(s), having flat slabs at the center
1g	Pit burial with a ramp and enclosed by cairn stone circle(s) (Figure 1)
1h	Pit burial with a passage and enclosed by cairn stone circle(s)
2. *Chamber burials*	
2a	Chamber burial with/without cairn packing and boulder circle(s)
2b	Passage chamber burial with/without cairn packing and boulder circle(s) (Figure 2)
2c	Portholed chamber burial with/without cairn packing and boulder circle(s) (Figures 3 and 4)
2d	Passage, portholed chamber burial with/without cairn packing and boulder circle(s)
2e	Chamber with a sarcophagus burial and with/without a passage/porthole and with/without cairn packing and boulder circle(s)
2f	Rock-cut chamber burial (Figures 5 and 6)
3. *Legged and unlegged Urn burials*	
3a	Urn burial with/without cairn packing and boulder circle(s) (Figure 7)
3b	Urn burial capped by a slab and with/without cairn packing and boulder circle(s)
3c	Passage urn burial capped by a slab and covered by a Kudai-kal (umbrella stone)
3d	Urn burial capped by a slab and covered by a Topi-kal (hat stone) (Figure 8)
3e	Urn burial capped by a slab and marked by a menhir
3f	Unlegged sarcophagus burial with/without cairn packing and boulder circle(s)
3g	Legged sarcophagus burial with/without cairn packing and boulder circle(s) (Figure 9)
Nonsepulchral (either commemorative or memorial (?) monuments)	
1	Dolmen (Chamber open on one side) (Figure 10)
2	Portholed dolmen (A closed chamber) (Figure 11)
3	Menhir (A monolithic slab) (Figure 12)
4	Stone alignment
5	Avenue (Figure 13)

Figure 3.1: Classification scheme for sepulchral and non-sepulchral monuments in India (Moorti 1994, 2008)

3.1.1 Sepulchral Megalithic Monuments: The various sepulchral categories are outlined below.

Pit burials are exemplified by megaliths like Megalith II of Wheeler's excavations at Brahmagiri (see Fig. 3.2). They consist of human remains (usually excarnated) placed in an unlined pit and may be indicated on the surface by a marker that may vary from a simple earth mound or cairn of rubble to stone circles or slabs. E. g. Wheeler (1948), Leshnik (1972), Sundara (1975), Devaraj et al (1996), Rajan (1998, 2005)

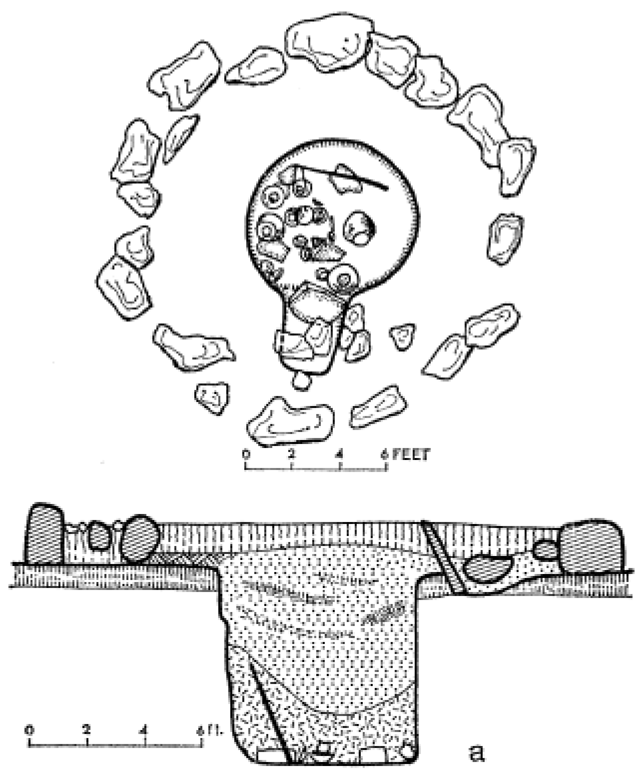


Figure 3.2: Plan and section of Megalith II at Brahmagiri (Wheeler 1948)

Chamber burials are excavations in the earth that are lined with stone slabs (or stone masonry as in the Vidarbha megaliths) and covered by a capstone. There might be a port-hole in one of the orthostats and it is common to see the stones interlocked in a "swastika" pattern to prevent inward collapse of the orthostats. Outward collapse is prevented by a dry walling of masonry blocks on the outside of the orthostats. The chamber is usually rectangular in plan and the

porthole is usually on one of the shorter sides. In earlier classification schemes, it was common to refer to such chambers as cists if they are wholly under the ground, as dolmenoid cists if they are only partially sunken into the ground and as dolmens if they are erected wholly above the ground (Sundara 1975).

Examples are found in Anglade and Newton (1928), Leshnik (1972), Sundara (1975), Devaraj et al (1996), Rajan (1998, 2005) etc. The cists may have a "passage" approaching the orthostat with the port-hole and the usual choice of surface markers ranging from cairn to boulder circle.

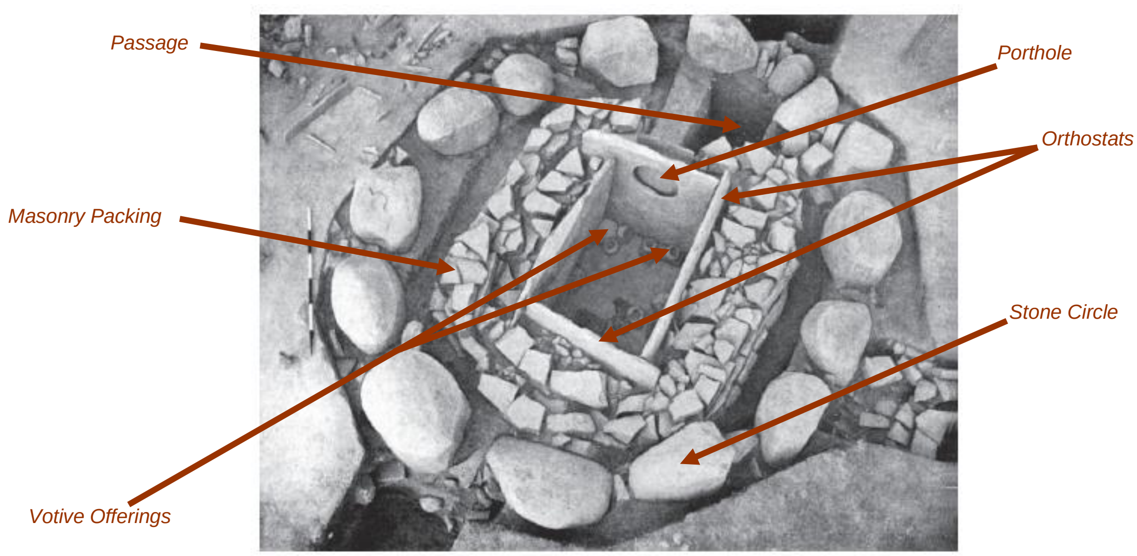


Figure 3.3: A view of an excavated chamber burial with boulder circle and passage (Wheeler 1948)

Figure 3.4: Cutaway view of a museum exhibit of an urn burial capped by a slab (S. A. Museum, Thrissur)

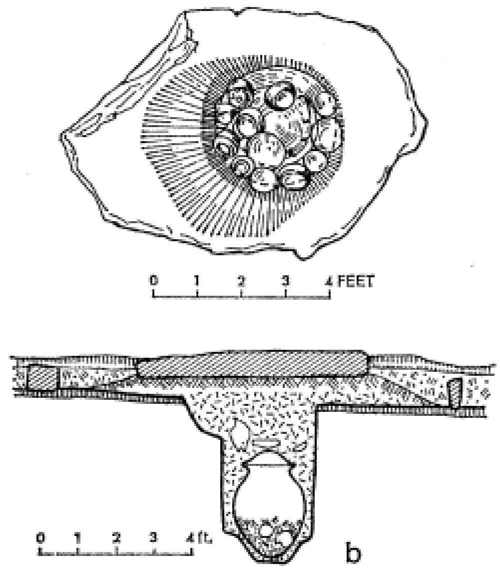


Figure 3.5: Plan and Section of Urn Burial at Porkalam (Leshnik 1972)

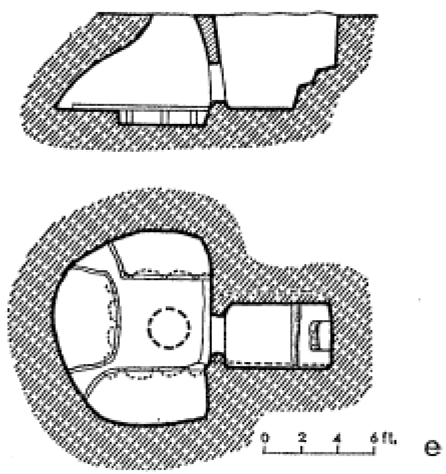


Figure 3.6: Plan and Section of Rock-cut Cave Burial at Kandanasserry (Leshnik 1972)

The urn burial was common in the Neolithic-Chalcolithic, though the position of the urn was horizontal, mouth to mouth. The continuation of earlier traditions, though with a stone appendage over the burial to mark it is noteworthy, indicative of a gradual change among the people of this culture. The **Megalithic urn burial** consisted of excarnate remains (de-fleshed bones) placed in an urn positioned vertically or in a sarcophagus and marked on the surface by suitable lithic appendage. Examples are found in Anglade and Newton (1928), Leshnik (1972), Sundara (1975), Rajan (1998, 2005), Joshi et al (2004) etc.

3.1.2 Non-sepulchral Megalithic Monuments: In this category are grouped together a wide variety of monuments, very likely to be varied in purpose as well. **Dolmens** are chambers either open on one side or having a port-hole on one of the four orthostats, erected wholly above the ground. Examples are found in Anglade and Newton (1928), Leshnik (1972), Sundara (1975), Rajan (1998, 2005) etc.

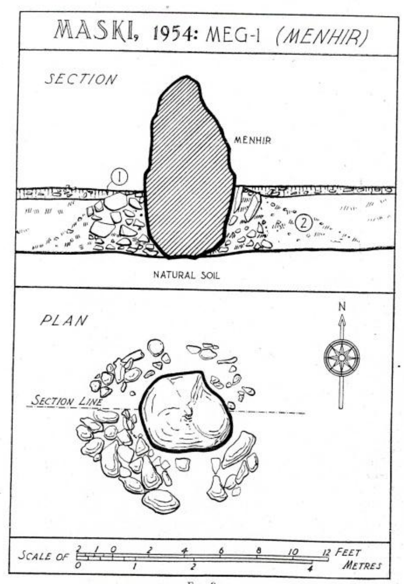


Figure 3.7: Plan and Section of Menhir at Maski (Thapar 1954)

Figure 3.8: View of an avenue at Hanamsagar

Menhirs are monolithic slabs that are erected above the ground and may be sepulchral in certain regions (Sundara 1975). **Stone alignments** and **avenues** consist of rows or grids of menhirs or boulders. Examples maybe found in Thapar (1954), Allchin (1956), Sundara (1975), Paddayya (1995), Devaraj et al (1996), Joshi et al (2004) etc.

3.1.3 Distribution of the various megalithic types in the Indian subcontinent: Prehistoric megalithic monuments of one typology or another are widely distributed in India from Jammu and Kashmir in the north to the tip of Kanyakumari in the south (see Fig.3.9, Brubaker 2001). But it is evident that, apart from a few clusters of outliers which are seen in the northern states of Jammu and Kashmir, Uttar Pradesh, Bihar, West Bengal, Rajasthan, Gujarat and Madhya Pradesh, the vast majority of prehistoric megalithic sites are located in the states of Maharashtra, Karnataka, Goa, Andhra Pradesh, Tamilnadu and Kerala in peninsular India (Fig.3.10).

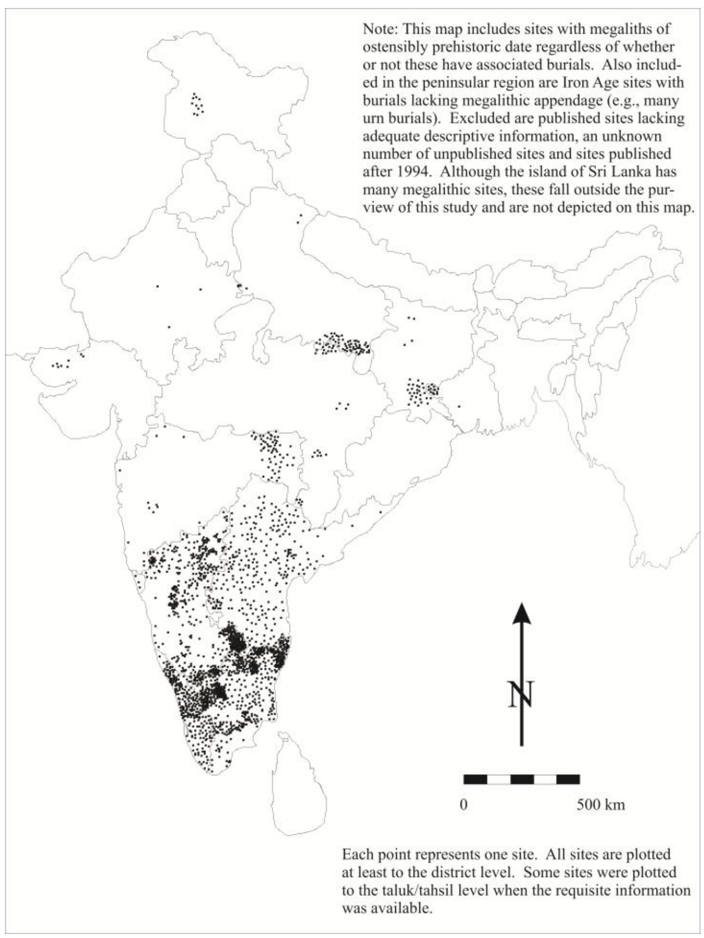


Figure 3.9: Showing the distribution of megalithic sites in India (Brubaker 2001)

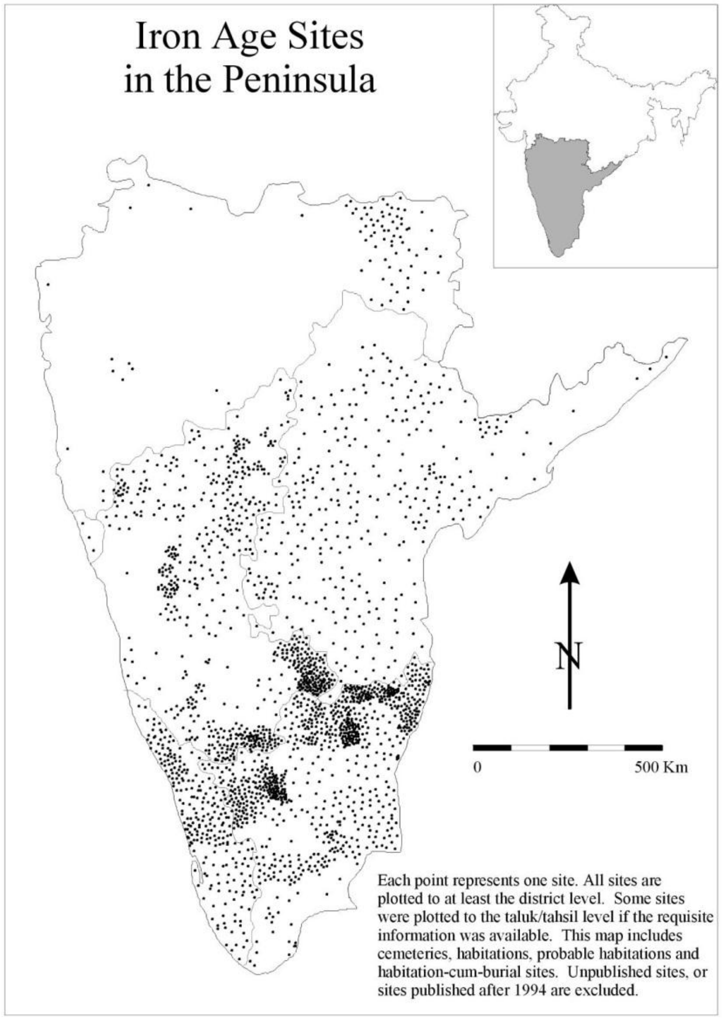


Figure 3.10: Showing the distribution of megalithic sites in peninsular India (Brubaker 2001)

The map in Fig.3.9 shows all types of megalithic monuments as well as habitation sites recorded up to 1994. Brubaker (2001) also discusses the distribution of various types of monuments, which shows the preference of certain forms over others in certain regions, such as the prevalence of stone circle typology in Vidarbha (Fig. 3.11). Also evident are the fact that certain forms, such as the stone circle seem to be a commonly adopted form over the entire range in southern India, whereas certain other forms, like the rock-cut cave burial seems to be limited in range (Fig. 3.12). The distribution of the rock-cut burials is easily understood in the light of the geological characteristics of Kerala and southern coastal Karnataka, with soft laterite rock, is

more conducive to the scooping out of material for this typology. Certain other aspects, like the distribution of alignments or avenues (Fig. 3.13) are challenged by the findings of our investigation.

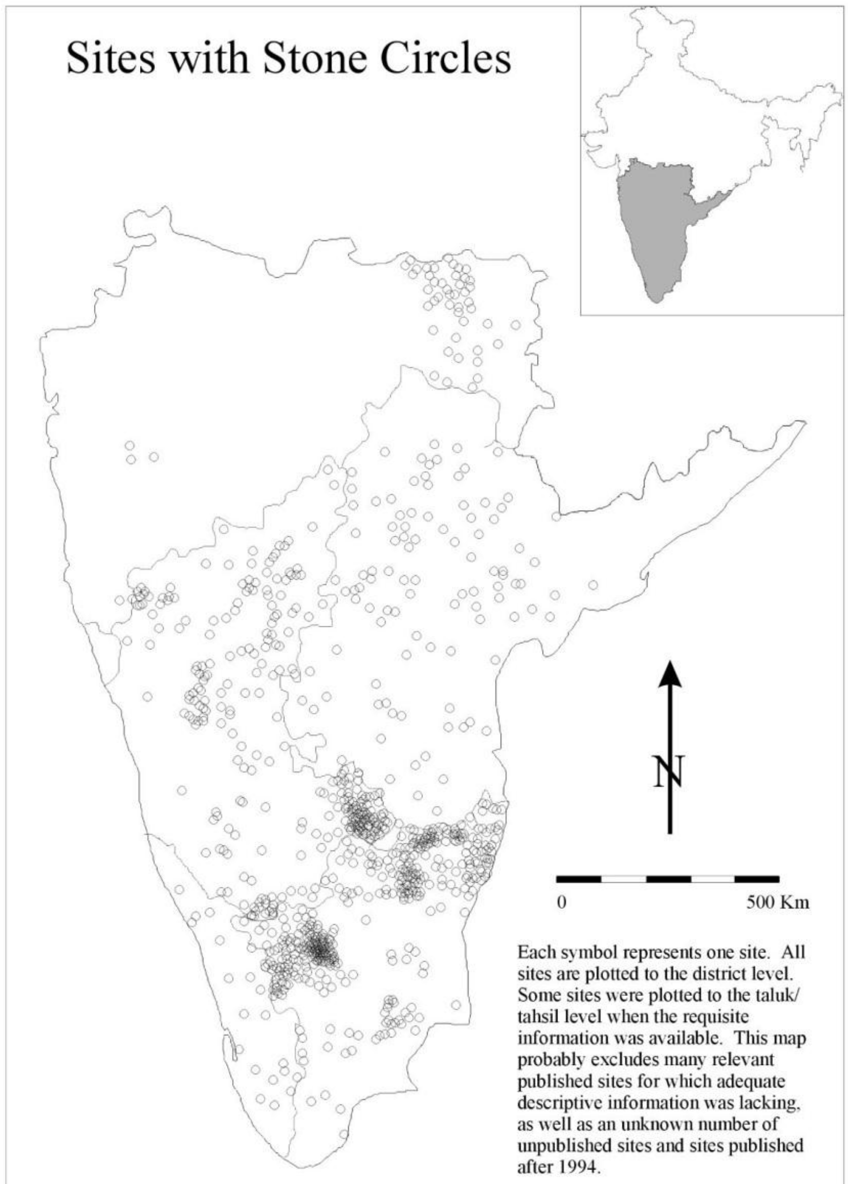


Figure 3.11: Showing the distribution of stone circle megaliths in peninsular India (Brubaker 2001)

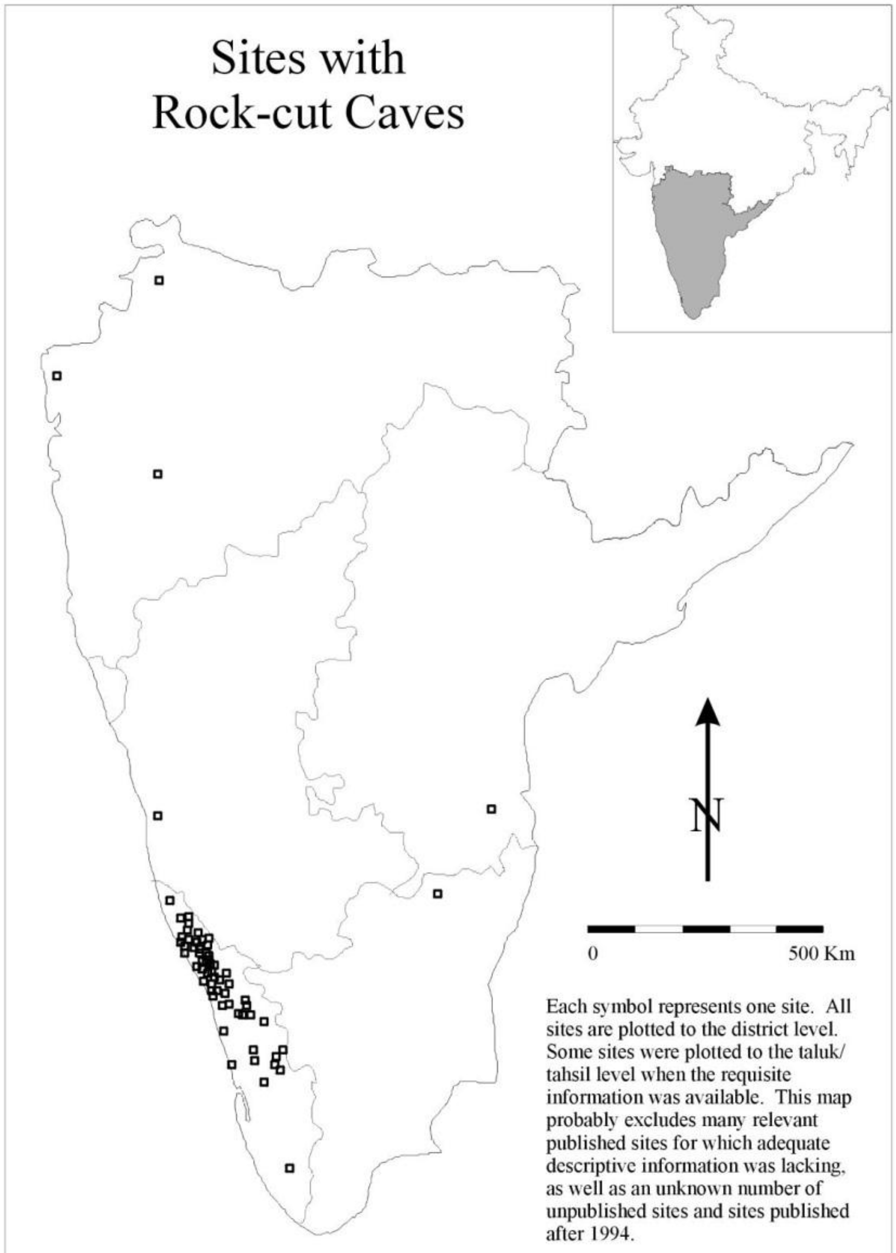


Figure 3.12: Showing the distribution of rock-cut cave burial megaliths in peninsular India (Brubaker 2001)

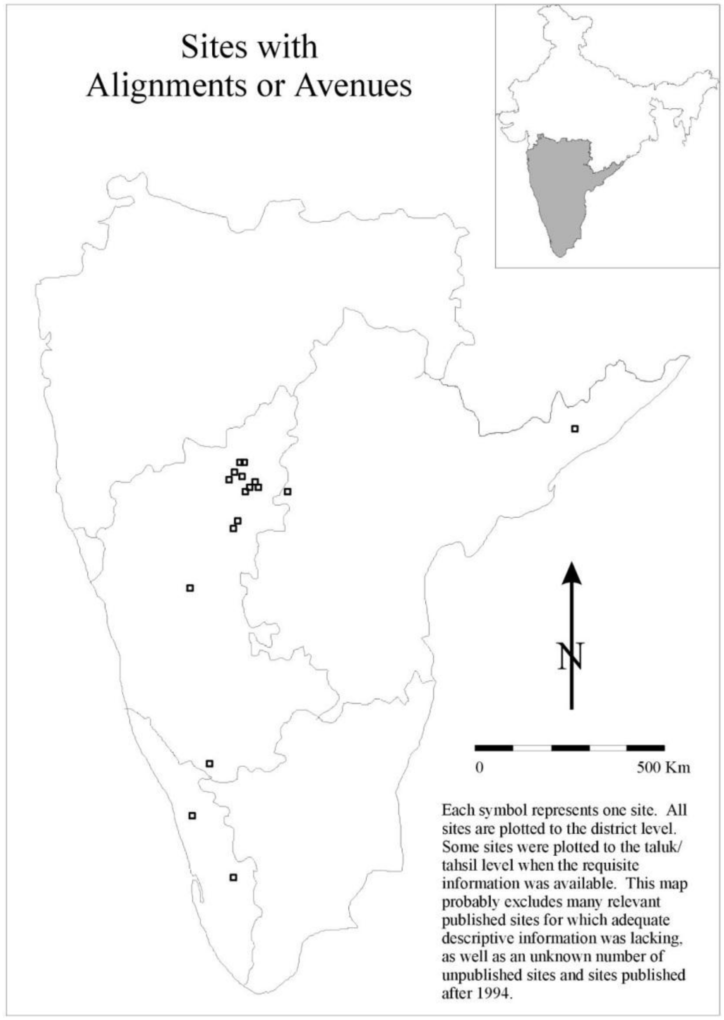


Figure 3.13: Showing the distribution of alignment/avenue sites in peninsular India (Brubaker 2001)

3.1.4 Basic tenets of megalithic architecture: For a vast majority of megalithic constructions, there seems to be a distinct concept in the minds of the builders as to what form they wanted to achieve, irrespective of the material available for construction at hand. Since these pre-literate societies have left no texts, the only clues we have are the monuments themselves, as to what were the concepts megalithic man was trying to express in his constructions. That there was an ideology behind the conception of the form of these monuments there can be no doubt – the exquisite portrayal of the form and concept of a burial marked by a stone circle at a rock-art site at Onake Kindi near Hire Benakal bears testimony enough.

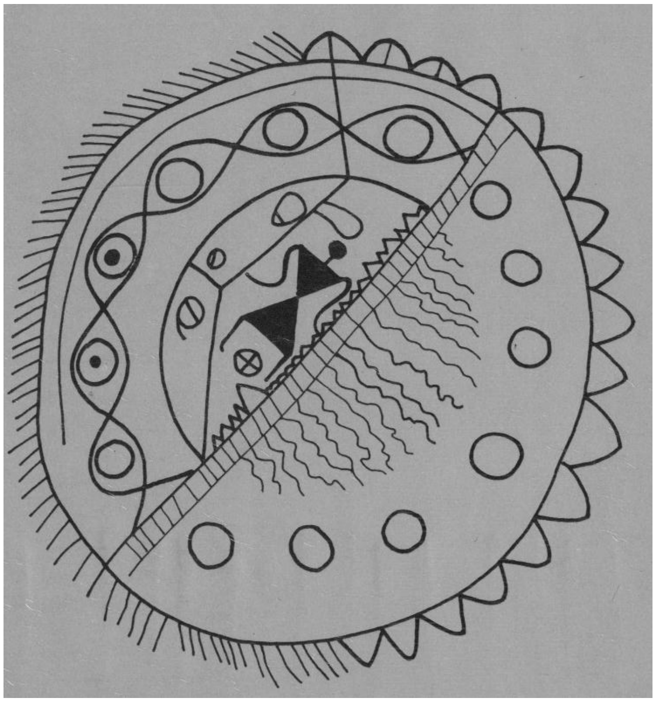


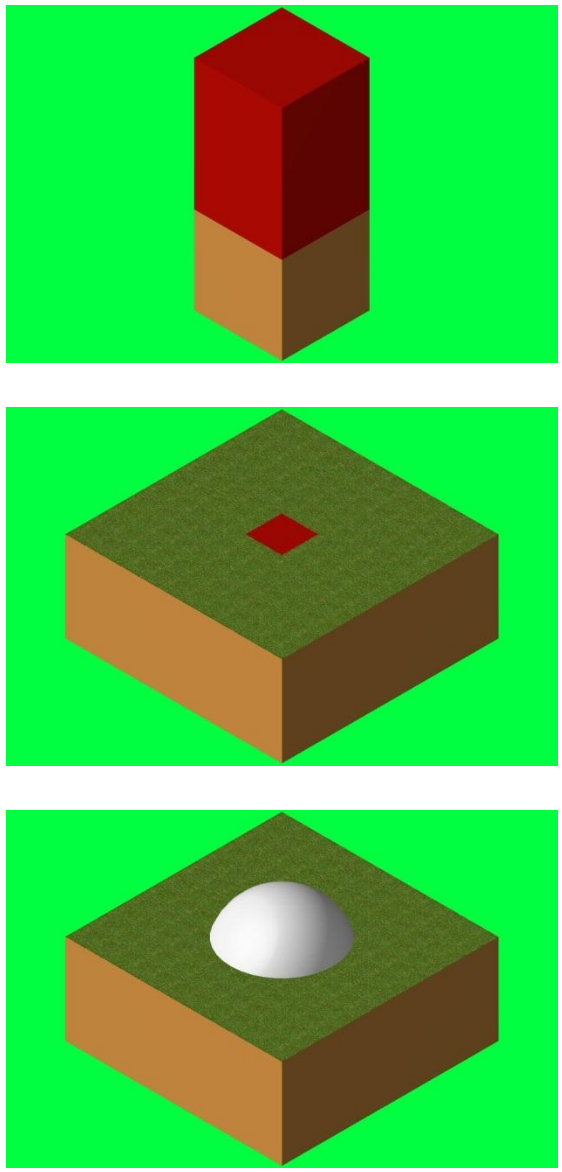
Figure 3.14: Line drawing of rock art at Onake Kindi near Hire Benkal (Moorti 1994)

Several scholars have looked at early literature like the Tamil Sangam literature and the Rig Veda for clues or references to megalithic practices (Sundara 1975). There are references to both cremation and burial (primary) in the Rig Veda – *agnidagdha* and *anagnidagdha* (Rig Veda X: 15, 14). Erection of stone or cairn stone circle over the remains of the dead is also mentioned in the Rig Veda (X: 18, 4). Pit burials seem to have been referred as *mrinmayam griham* in the Rig Veda. There is an appeal (X: 18, 11) to Mother Earth to rise up above him, to provide comfort and to cover the dead like a mother does to a child with her garment. There are instances of burying the dead in a jar that looks like a pregnant woman, seeming to suggest that the dead are entering the womb of the earth.

The recurring theme of the chamber: It is in the light of the above that we examine the basic theme of the chamber that seems to recur in various incarnations in the variety of sepulchral megalithic monuments. The practice of burying the deceased in a pit or urn within the habitation area was prevalent in the Neolithic-Chalcolithic period. This practice during the overlap stage and the Iron Age Megalithic stage (e. g. Maski) was changed over to that of burying the dead away from the habitation area. As evident from sites like Terdal, the Chalcolithic people began

the practice of raising cairns over the burial spot, which were later developed into the pit circles (such as at Brahmagiri) and stone circles, cairn circles (as at Maski) etc.

It is the chamber as a geometrical solid (or void!) that we see in the form of the unlined pits or cists/dolmenoid-cists/ dolmens or even the rock-cut chambers or even the seemingly different kudaikal. A couple of examples of the development of a megalith type around the theme of the chamber are given below (Figs. 3.15 & 3.16)



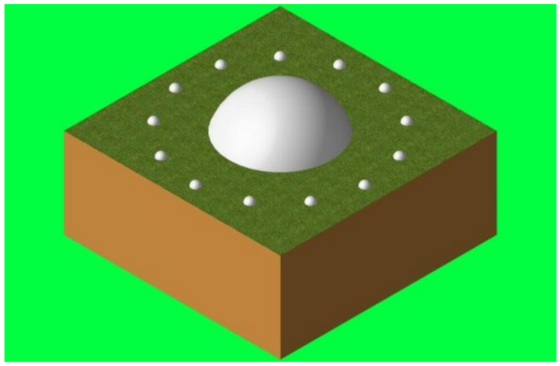
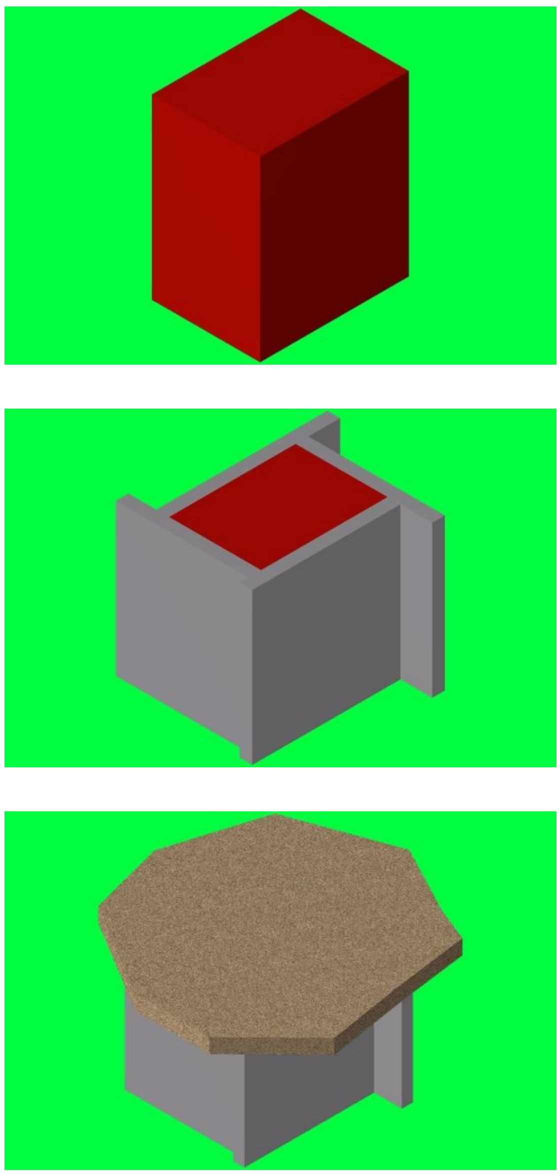


Figure 3.15: Showing stages of development of a cairn circle over a pit burial



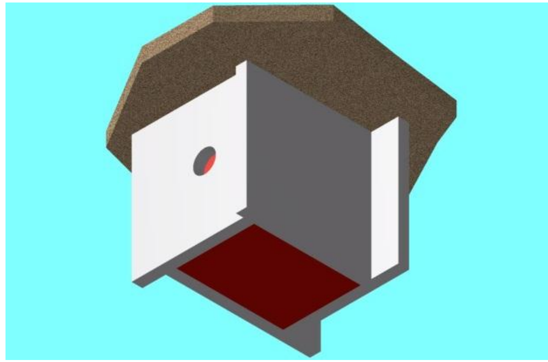


Figure 3.16: Showing stages of development of a port-holed dolmen

Materials of construction: The materials of construction of the megaliths vary according to the availability depending on the geographical region. Thus we find local stone put to use to construct the forms the builders had in their mind – be it the sandstone dolmens of the Aihole group or the granite dolmens of the Hire Benakal group or the carved laterite kudakkals and topikals of Kerala.

Regarding the raw materials of the megaliths, quartzitic sandstone, granite, laterite, Deccan trap are the principal rock material variously used for construction of the chamber stone circles (Sundara 1975). Besides, pegmatite or white quartz fragments, river-worn pebbles of quartz and conglomerates were also used though not on a large scale for their constructions. The river-worn pebbles, rubble of quartzites, quartzite sandstones and of Deccan trap were utilised for raising cairn and the laterite neatly cut into rectangular blocks was used for the circles and the sandstone slabs exclusively for the chambers as the supply of large slabs that could be directly used for chambers, is enormous.

Construction techniques and form: The skill in using the stones varies depending upon the site in question and seems to suggest a chronological succession as skills and techniques in working with the various stone types develop. For example, the slabs of the Hire Benakal group are thin, well-cut to the required size and the edges are straight, unlike the rough, thick and large-sized slabs of the Aihole group, the edges of which are sometimes crudely dressed. The device of interlocking the stone slab orthostats to prevent inward collapse is found at Hire Benakal but not at Aihole suggesting that the latter was the earlier site. Figs. 3.17 and 3.18 illustrate the same.

Figure 3.17: Showing one of the dolmens of Meguti Hill, Aihole

Figure 3.18: Showing dolmens at Hire Benakal

Sometimes, different typologies within a single site seem to indicate that the site was in use over a long period of time and that techniques evolved in that span of time. For instance, the typology of rock-shelter chamber, irregular polygonal chamber, cists and transepted cists and the dolmen with interlocking orthostats at Hire Benakal seem to indicate an evolutionary sequence. The quarrying of stone slabs by firing seems to have facilitated the construction of first the irregular polygonal chambers and then the cists and dolmens, with the rock-shelter chamber being the earliest typology (see Figs. 3.19 to 3.23).

Figure 3.19: Hire Benakal – Rock-shelter Chamber

Figure 3.20: Hire Benakal – Irregular Polygonal Chamber

Figure 3.21: Hire Benakal – Transepted Cist

Figure 3.22: Hire Benakal – Dolmenoid Cist

Figure 3.23: Hire Benakal – Port-holed Dolmen

Over the vast variety of sites, there seem to have evolved two techniques of preventing inward collapse of orthostats. One – involving a "swastika" like plan of interlocking orthostats has already been discussed. The other is by having a trapezoidal plan, wherein the hind orthostat is held in place by the two side orthostat the edges of which outstretch the hind orthostat. And the front edges of the side orthostats hold the front orthostat in place, whose outer edges outstretch the side orthostats. The cairn packing, sometimes up to the capstone level, prevents outward collapse.

At every stage from the selecting and quarrying of stones to the actual construction, the megalith builders displayed considerable skill. Their knowledge of geometry in setting out these monuments is commendable. The provision of a boulder circle at the periphery to hold the cairn packing in place is another example of the engineering skills of the megalith builder. In a large

cairn at Bandipur, the use of sunken-slab circle to support the cairn was also observed (Menon, Vahia and Rao 2011). The relative proportioning of chamber, passage, enclosing circles etc. speak of the design and construction skills of megalithic man.

Orientations: The orientations of megalithic tombs can provide clues to the directional symbolism that megalithic man believed in. Many of the earlier typologies, such as the Konnur type, seem to be south-oriented (Sundara 1975). At Brahmagiri, the port-holed cists invariably point east. The megaliths of Aihole were found to have no directional preferences in the course of this investigation, whereas the dolmens of Rajan Koluru invariably pointed southwards. Wanke, as quoted in Sundara (1975) seems to find megaliths in the north facing south and those nearer the equator facing east. In Europe, studies have shown megalithic monuments at several sites to face sunrise at some point of the year for the given location, while some sites showed topographical reasons for orientation (Ruggles 1999, Hoskin 2001). Studies on archaic (750-480BC) and classical (480-323BC) Greek temples have also shown that there is an astronomical pattern to orientation of these (Salt 2009).

It is also likely that some of the non-sepulchral megaliths were altogether different in function – some of the stone alignments and avenues have been suggested as calendar keeping devices or at least ritualistic with respect to the celestial cycles (Ruggles 1999, Hoskin 2001). It is clear in the light of these facts, very few systematic studies have been done on the orientation aspects of the South Indian Megaliths.

3.1.5 Megaliths and later architecture: It is surmised that the sepulchral and other architecture of the megalithic period had enormous bearing in the subsequent development of indigenous architecture of these regions. The cognitive capability of the megalithic people was much more developed than that of the Neolithic communities (Selvakumar 2005). It is also argued that Buddhist stupa monuments being closely related to relic worship and death rituals, evolved from the cult of the dead. Selvakumar (2005) quotes Longhurst's (1979) argument that Kudakkals were the forerunners of the stupas.

Ray (MS, in prep.) makes the case that the diverse nature of the sacred landscape in the early centuries of the Christian era, with the Hindu temple co-existing with the Buddhist and Jaina shrines, memorial pillars and, in some cases, Iron Age burial structures is suggested by the

survey of the archaeological record. This is in contrast with the conventionally held view that Buddhist monuments are the earliest religious structures in South Asia (dated to the 4^{th} – 3^{rd} centuries BC), followed by the Hindu temple, which emerged in the 7^{th} – 8^{th} centuries AD. Ray puts forward the case that the period between the 2^{nd} – 1^{st} centuries BC and 4^{th} century AD was a period of creativity and experimentation as far as religious architecture was concerned. Schopen (2010) mentions the trait of Buddhist monks making protohistorical burial grounds the centre of their activity.

A prehistoric origin for the Hindu temple? Discussing the architectural origins of the Hindu temple, Kramrisch (1976), argues an origin in the dolmen for the square plan of the *garbha griha*. She quotes the cubical form of the flat-roofed sanctuary of the earliest Gupta Age temples. All these temples are built of large, well-cut stones, dressed to level beds and placed one upon the other without any mortar or cementing substance. Various phases of stone temples of the dolmen type are to be found in South India, according to Kramrisch; some of roughly hewn stones and with a stone Linga in the interior, others of carefully dressed slabs of stone accurately fitted at the angles, with their walls resting upon a plinth, about one foot high and not planted on the ground like the wall-stones (orthostats) of a dolmen.

Kramrisch also draws parallels between stone circles and *pradakshina patha* of temples, as also between menhirs and Lingas. She argues that dolmen and menhir are not just memorials to the dead but they commemorate the importance of the site which is marked by them. Interestingly, she mentions that “Kynmaw” – which means “to mark with a stone” is the word used by the Khasis of Assam (who have a living tradition of megalithism), in connection with monoliths, table stones and cromlechs. The stone dolmen and menhir, and stone shrine and Linga, she says, are cognate.

3.2 Megaliths as direction and location markers: It has long been recognized that many megalithic sites (Avebury, Stonehenge, Callanish) contain indicators showing rising or setting points of the sun at the solstices (Baity 1973, Cooke et al. 1977, Ruggles 1999, Kelly and Milone 2005). Some investigations also show that there is a probability amounting to a certainty that other equally-spaced dates throughout the year are indicated. Research also shows that the moon was carefully observed (Thom 1967, Hadingham 1983) and that the first-magnitude stars may also come into the picture. The most obvious argument which comes to mind against the use of

the stars is that there are so many stars that almost any line is certain to show the rising or setting point of some star or the other. This argument can be resolved to some extent because only the rising points of first-magnitude stars can be of any practical use in observations close to the horizon due to increased amount of atmospheric extinction of light. A third-magnitude star cannot, for instance, be observed while rising or setting — except perhaps on an elevated horizon (where a mound – artificial or natural creates an artificial horizon several degrees above the true horizon). A star of such faint brightness does not become visible even in clear weather until it has attained an altitude of at least three degrees.

During long winter nights, especially at higher latitudes, it is evident that throughout the greater part of twenty-four hours the stars would be the only indicators of time available. The hour would be indicated by the rising or setting of certain stars or by their transit over the meridian. There have been many claims that these methods were in use and that there remain many indicators of rising and setting points of first- magnitude stars as well as meridian transits as indicated by many slabs and alignments still standing (Fig. 3.24).

Figure 3.24: The standing stones of Callanish - a possible calendar device?

3.2.1 Megaliths as possible calendar devices: It has been suggested that in highly organized communities such as must have existed it after the Neolithic Revolution, it would often be necessary to know the time of day or night for practical and ritualistic purposes. Much speculation has been directed to the necessity of accurate time-keeping for ritualistic purposes but certainly more practical reasons also existed. From the suggestions of Thom (1967), a civilization which could carry a unit of length from one end of a large region to the other, and perhaps much further afield, with an accuracy of 01 per cent and could call for the erection of 5000 to 10000 megaliths must have made demands on its engineers. It is difficult to think of these responding without making use of time-keeping. The organizing effort which would be necessary to transport and erect numbers of stones some weighing up to 30 tons must have been tremendous. The feeding of hundreds of men and the necessity of starting before dawn in the shorter winter days of the megalithic cultures Thom studied made knowing the hour extremely important. Thom (1967) thus argues that the methods of obtaining time from the stars must have been well understood. To obtain time from the stars the date must be known and this probably came from following the sun's cycle at the calendar sites. Thom and other workers conjecture that, initially the necessary indicators would almost certainly have been of wood but it appears that in many places stone was substituted.

Though the precision of the alignments that Thom had claimed for many megalithic monuments have been found to be erroneous by later re-assessment (Ruggles 1999) due to selection effects and large number of free parameters that could be adjusted to provide a close fit between the high-precision lunar theory and observed data, the sheer volume of work and accurate survey of monuments that Thom carried out remains the foundation of much of archaeoastronomy even today. Also, most of the low-precision alignments found by Thom hold good.

3.2.2 On what constitutes a reliable sightline: Several researchers have tried to define what exactly could be considered as a valid sightline (Thom 1967, Cooke et al. 1977, Hoyle 1977, Heggie 1981, Norris 1984, Ruggles 1999). Thom (1967) was willing to consider a slab, two or more stones "not too far apart", a circle and a close outlier as well as two circles to be "azimuthal indicators. Hoyle (1977, p. 68), in his discussion of Stonehenge, explored the possibility that the foresight of alignments to the solstices could be deliberately set inside the line of alignment so that the exact date of the solstice could be determined by halving the period taken by the sun to

cross this line and return to the same position. This is necessitated by the fact that the movement of the day-today rising/setting position of the sun is very minimal near the solstices and sightlines of infinite length is required to discern this fine motion. Hoyle (1977, p76) also studied observers' eyelevel views of aligned stones and the visible horizon. Norris (1984) discusses the reliability of stone rows and alignments, and even the flattened face of a single stone slab as an indicator of azimuth. Heggie (1981) also discusses several case examples and possibilities of sightlines in the context of various types of monuments like stone circles, cairns and rows etc.

Ruggles (1999), in his discussion of the re-assessment of Thom's high-precision lunar sites, attempts to lay down a methodological framework for assessing alignments of possible astronomical significance. He classified likely structures for deliberate astronomical orientation into an order of preference, so that, at any given site only those structures with the highest classification could be considered as potential indications. The top six classes of Ruggles' classification are:

Table 3.1: Showing classification of structures for deliberate astronomical orientation (Ruggles 1991, p. 70)

S. No.	**Class of megalithic structure**	**Order of preference**
1.	A row of three or more standing stones or at least two aligned slabs	6 (highest)
2.	One or two standing stones together with a number of prostate stones that could have served as a row of at least three stones	5
3.	A pair of standing stones (not aligned), a single slab together with a prostate stone that could have stood in line with its orientation, or three or more prostate stones that could have formed a row	4
4.	Two stones, not both standing	3
5.	The flat faces of a single slab	2
6.	The flat faces of a single slab of uncertain status	1 (lowest)

The most commonly expected alignments are (Fig.3.25) involving two or more slabs involves the alignment of similar-sided faces of the stones. However, it is interesting to note that, in the course of this investigation, we have come across alignments (Fig.3.26) wherein the opposing faces of stones placed far apart frame an event on the local horizon (Menon and Vahia 2010; Menon, Vahia and Rao 2010, 2011, 2012a, 2012b).

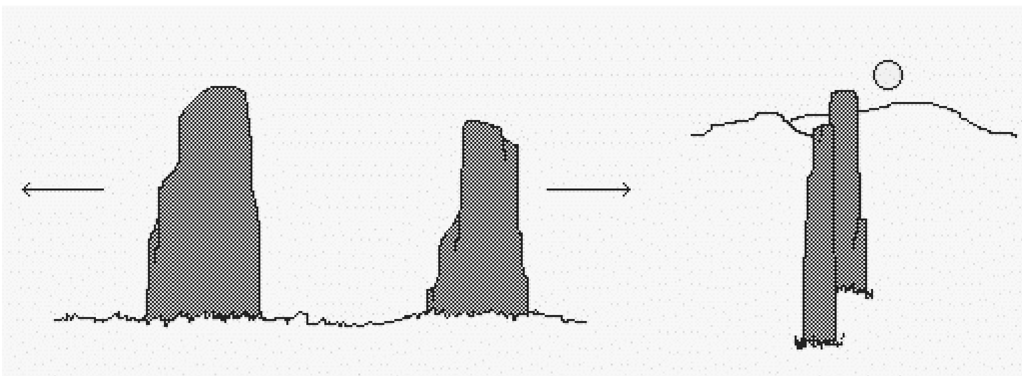


Figure 3.25: An alignment of two standing stones

It is clear from the above discussion that extreme care has to be taken before deciding that a given layout of stones indeed constitutes a valid sightline that can be investigated for possible astronomical significance. Points to be considered while making this decision range from archaeological inputs about the contemporaneity of the various components included in the purported alignment (as exemplified by the sarsen and bluestone circles and trilithons, the station stones and the car park post holes, which are shown to be from different periods in the history of the composite monument Stonehenge) to visibility of each other and the horizon from inferred viewing points and whether a given rough line of stones is too inaccurate to constitute a sightline.

In the present chapter we have discussed the variety of form encountered in the design and layout of megalithic typologies in the Indian subcontinent. The distribution of the various types in the zones of occurrence of megaliths in India was also discussed, as also the details of design and construction, and orientation. The possible relationship of megaliths with later architecture on the Subcontinent was also explored in brief. The possibility of megaliths serving as direction and location markers was discussed and also the question whether they could have served as calendar devices. The reliability of various classes of alignments that could be considered as deliberate

astronomical alignments was assessed as well as the considerations that were to be kept in mind for gauging what constitutes a valid astronomical sightline.

Figure 3.26: Showing a sightline from this investigation wherein opposing edges of two menhirs frame winter solstice sunset (Menon and Vahia 2010, 2011)

Chapter 4: Our Approach

In this chapter, we examine possible astronomical intent in the form and layout of the megalithic monuments of peninsular India. We put special emphasis on insights that must have gone into the design and layout of megaliths, as well as into their relationship with their surroundings. We discuss this in the context of the sites visited by us and a study of the material culture of the cultures that built these monuments, including the monuments themselves, since the only graphic clues that these pre-literate societies left behind may be among the scattered panels of rock-art at or near many megalithic sites.

4.1 Background – megalithic knowledge systems and belief systems: In a larger perspective, understanding the astronomical knowledge of the megalith builders as codified in the monuments themselves is a part of a vaster scheme to understand the knowledge systems possessed by the megalith-building cultures. It is evident that these cultures possessed a good working knowledge of geometry, geology and engineering, judging from the procurement of large stone slabs of various materials depending on the region, their transportation and working into components of the required size and shape, and their final erection in desired patterns. It is also evident that these structures played a very important role in the lives of the people who built them – the sheer amount of energy and time expended by these early cultures on the construction of megaliths bears testimony to this. But what exactly these monuments meant to the megalith-building society is lost to us today. We know that a large fraction of megaliths were burials, usually secondary burials of more than one individual. However, what governed the design of the structure to house these burials? Was there belief in after-life? Clues from rock-art, such as at Onake Kindi (see Figs.1.11, 3.14), suggest that the megalithic artist is depicting that the form of the megalithic burial (boulder-circle, in this case) goes beyond functional meaning, though the exact meaning of the wave-like pattern in one half of the burial, the ladder-like structure dividing this from the other half depicting the actual burial and the serpent-like forms around the boulders of the circle as well as the petal-and-ray pattern surrounding the composition, can only be guessed at. The location of this depiction of a megalith – on a horizontal overhang from the vertical panel where everyday scenes of cattle and people are drawn, is also probably of symbolic significance.

Comprehension of some of these issues helps us to better grasp the mind of our megalith-building ancestors. Did their minds rise above the mundane, repetitive activities of daily life for survival to grapple with the larger questions of the nature of the universe around them?

Conventional archaeology provides us a rich understanding of bygone societies with an understanding of their material culture – which includes artefacts such as pottery, weapons and implements, beads and other adornments etc. as well as remnants of organic material such as food grains, bones of animals and birds used for food, interred bones and other such material. While this "material text" enables us to understand quite a bit about the state of technology that existed at a given period, not much headway can be made in the understanding the status of knowledge, and hence, the intellectual level possessed by a given culture. Modern archaeological methods today have moved away from the traditional concept of an archaeological '"site"; for instance, an area containing conspicuous megaliths can easily be called a "site" but the human activity that gave rise to those monuments was played out on a landscape much larger than the site defined by the monuments themselves. Today, Landscape archaeology examines human activity on a larger scale – on the entire physical landscape of consequence. Also, experimental archaeology and the modelling of growth and spread of cultures using computational models etc. are expanding the traditional area of engagement of archaeological research. However, a study of the monuments themselves as they have been left behind, as expressions of a cultural group presents the only way we can hope to understand the collective mind of these cultures. Information on what kind of knowledge megalith-building societies possessed would be an important step in the understanding of the intellectual level possessed by their culture. This could play an important role in better comprehension and interpretation of the other facets that are known about their culture, for instance, their burial practices and associated as well as other belief systems.

Developing an understanding of directional preferences in the orientation of structures could help in understanding of preferential orientation of later architecture in the subcontinent – both religious and secular. Similarly, studies of the astronomical knowledge of early inhabitants of the subcontinent could provide clues to the origin of the rich wealth of astronomical knowledge, symbolism and lore that arose later in the region.

4.2 Aims and objectives of the current study: This study investigates the megalithic structures of peninsular India for possible astronomical intent in their design and layout. By "astronomical intent" I mean deliberate alignment of a structure or its components to points of astronomical significance on the horizon or otherwise. This could be as simple a matter as the deliberate alignment of a burial structure to face sunrise or sunset or even a structure designed to keep track of the heavenly cycles. The aim is to determine whether any aspect of the heavens influenced the design or layout of any of the megalithic typologies.

A fair understanding exists of these monuments from the archaeological perspective from the excavations and other archaeological exploration of Indian megaliths in the nearly 200 years since the first report of an Indian megalith in 1823 by Babington. There exist large gaps, however, in our understanding of these structures – viz. their chronology and their relationship to the habitation sites of their builders. The biggest contribution of archaeological investigations has been the identification of a group of monuments diverse in form, material and expression as different facets of the same material culture. It is now required to concentrate on the differences – what are these monuments? What were the non-sepulchral megalithic monuments used for?

The current classification of megaliths into sepulchral and non-sepulchral does not help in specifying what the latter were used for. It is highly likely that this category lumps together a large number of monuments of diverse purposes. As discussed earlier, dolmens were most probably memorial in nature considering their similarity in structure to cist burials and dolmenoid cists which are funerary in purpose. However, not much is known about the purposes for which many other non-sepulchral megaliths were erected. Menhirs have been found in sepulchral contexts at many sites in Kerala, but many menhirs – like the ones excavated by Thapar (1957) at Maski have been found to be non-sepulchral. Thus it is obvious that, at least in the case of megaliths like menhirs, their possible use has to be understood in the context of their setting, since it is likely that menhirs may have served various purposes depending upon where they were erected. Even more mysterious are the stone alignments or avenues, the exact meaning of these monuments still elude scholarly research.

It is possible that several or at least some of these monument types have astronomical purposes? It is almost impossible to infer these, if any, from published reports and descriptions of megalithic sites and monuments since it is essential to understand the relation of the monument

with respect to the site to test a given monument for possible astronomical alignments. For instance, a possible sightline to the rising or setting point of a celestial object may be inferred from a well=drafted and oriented plan of the monument, but this might well be negated if one considers topographic data of the surroundings. Hence it is usually necessary to undertake a fresh survey of a site from the perspective of archaeoastronomical investigations.

Thus, in a sense, we are attempting to understand the relationship between an object (a megalith) and a place (its physical context in the site) and trying to figure out if the builders were attempting to relate it to the cosmos by incorporating any deliberate orientations of the monument as a whole or any of its components. This "contextualisation of archaeological features within the broader canvas of their site and surroundings" to explore if there were any celestial basis to their setting out is what forms the backbone of this study. For instance, was there astronomical intent in the setting out of monuments or did celestial considerations and not just those of livelihood even influence factors like site selection?

In essence, this study is about trying to comprehend a small but important facet of the cultural phenomenon of megalithism on a larger (geographical) canvas from published literature, interaction with other research workers and mainly through independent fieldwork.

4.3 Summary of aims and objectives:

4.3.1 Aim: To investigate a selected sample of the megalithic monuments of peninsular India for possible astronomical intent in their form design or layout with a view to understanding megalithic knowledge systems. Astronomical intent may include deliberate alignment of a monument or any of its components to directions of astronomical significance.

4.3.2 Objectives:

- To understand the typology and distribution of the various megalith typologies existing in the subcontinent and shortlist a sample for studying the aim stated above, representing each megalith type.
- To study the design and layout of the various structures at the shortlisted site.
- To investigate the monuments at the shortlisted sites for possible astronomical sightlines.

- To test, both statistically and by other means, whether there is a realistic chance that these alignments, if any, could have arisen purely by chance.
- To determine whether conclusions about any aspects of the astronomical knowledge of the megalith-builders can be drawn from the study of these monuments alone.

In addition, it is expected that insights about structural and construction techniques, stone-working skills, stylistic evolution etc. of megalith types might emerge from the study of monuments of similar type in different sites.

4.4 Methodology: The methodology adopted for this study is summed up in Fig.4.1.

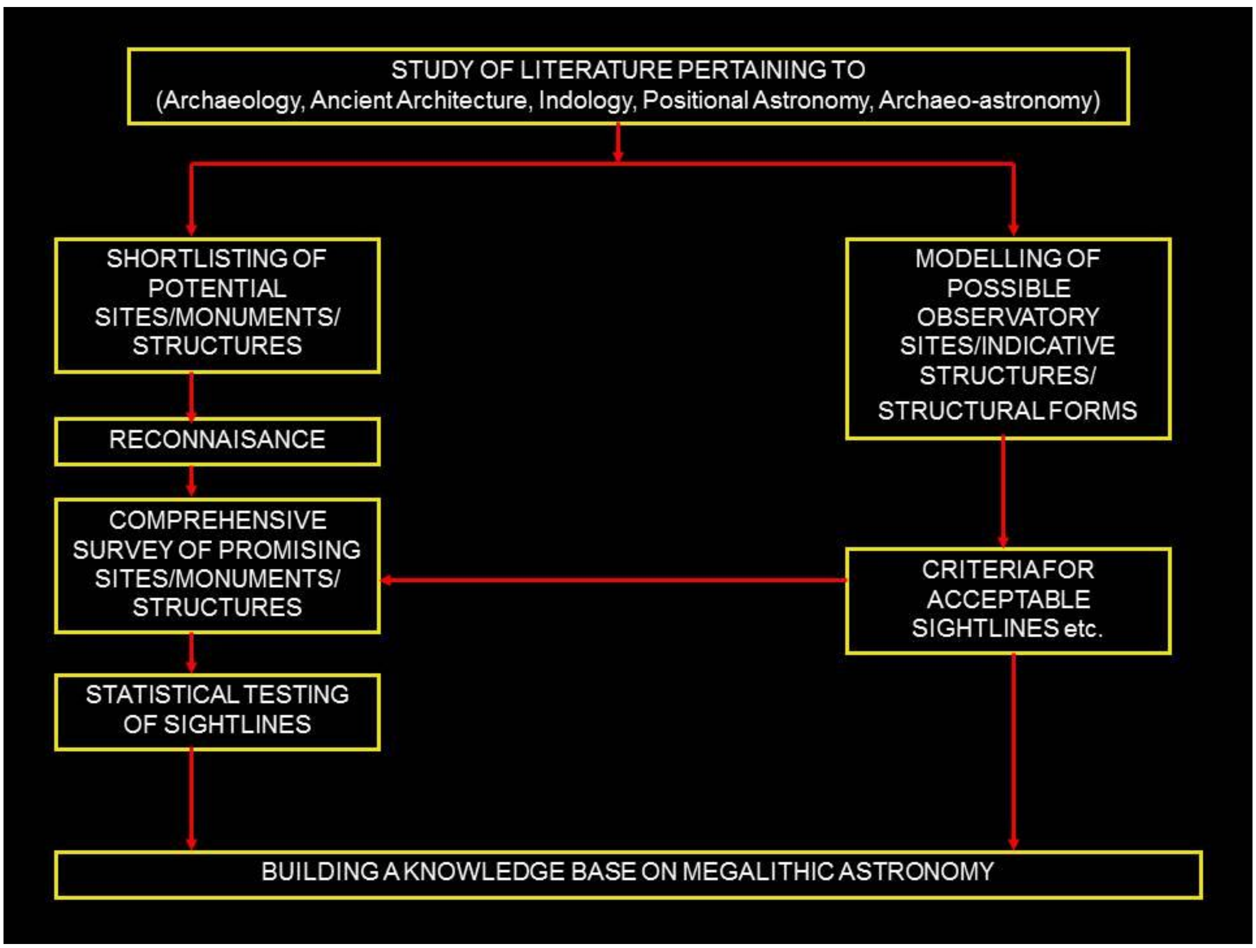


Figure 4.1: Methodology adopted for this study

The first stage in the study was a thorough search of all relevant literature, including archaeology and megaliths, ancient architecture, Indology, positional astronomy, archaeoastronomy etc. This was also bolstered by discussions with experienced research workers in megalithic studies. From the discussions and studies of relevant literature, a shortlist of sites to be visited was drawn up. Care was taken to cover all the major typologies of megalithic monuments in various regions, though the area of study was limited to north and south Karnataka and Kerala – a size that permitted reconnaissance visits to many sites followed by rigorous fieldwork at selected sites, all within a reasonable amount of time. A site at Burzahoma, Kashmir and three sites in the Vidarbha region near Nagpur were selected as comparison sites at sufficient geographically removed locations. A total of 31 sites including the comparison sites at Kashmir and Vidarbha as well as the sites in Karnataka and Kerala were visited for reconnaissance (See Table 4.1). One additional megalithic site at Vadakkipatti in Tamilnadu was visited to study stylistic variations. One site visited (Konan Kallu, Karnataka) turned out to be non-megalithic and is not listed below. Three other sites visited (Santhekatte, Hoynali and Kabbina Kallu, all in Karnataka) had only single standing stones that could be megalithic menhirs, but are not listed below. Out of the visited sites, two sites (at Kyaddigere near Aihole and Gudde Maradi near Shimoga) were found to have been completely devoid of monuments, the megaliths reported in earlier studies having been completely destroyed in development activities. Two hitherto unreported megalithic sites – Chikel Chetti near Bandipur and Aaraga Gate near Tirthahalli were discovered in the course of fieldwork for this study (Menon, Vahia and Rao, 2011). Of all the sites visited, Nilaskal, Byse, Vibhutihalli, Bandipur, Hire Benkal and Onake Kindi were visited again several times for surveys. Studies of design and layout and surveys for orientation data were carried out at several other sites, as listed in Table 4.1.

Table 4.1: List of the megalithic sites visited (not including 5 sites mentioned above)

No.	Site (in order of visit)	Type of megalithic site	Condition	Nature of visit (s)
1	Brahmagiri, Karnataka	Chamber/pit burials	Severely disturbed	Reconnaissance

2	Marayoor, Kerala	Dolmens, rock art	Disturbed	Reconnaissance
3	Burzahoma, Kashmir	Neolithic, megalithic, pit burials, menhirs		Reconnaissance/comparison
4	*Chikel Chetti, Karnataka	Cairns, chamber burials	Disturbed	New discovery, surveyed
5	*Hire Benkal, Karnataka	Chamber burials, dolmens	Mostly intact	Orientation surveys
6	*Onake Kindi, Karnataka	Rock art	Mostly intact	Rock art documentation
7	*Nilaskal, Karnataka	Avenue	Mostly intact	Surveyed
8	*Byse, Karnataka	Avenue, cairns	Mostly intact	Surveyed
9	Heragal, Karnataka	Avenue?	Mostly intact	Reconnaissance
10	Mumbaru, Karnataka	Avenue?	Disturbed	Reconnaissance
11	Eyyal, Kerala	Rock-cut burial	Mostly intact	Orientation survey
12	Kudakallu Parambu, Kerala	Kudakkals, topikals, multiple hood-stones, menhir	Mostly intact	Orientation surveys
13	Chowwannur, Kerala	Rock-cut burial	Mostly intact	Orientation survey
14	Kakkad, Kerala	Rock-cut burial	Mostly intact	Orientation survey
15	Kattankampal, Kerala	Rock-cut burial	Mostly intact	Orientation survey
16	Ariyannoor, Kerala	Kudakkals	Disturbed	Orientation surveys
17	Kandanasserry, Kerala	Rock-cut burial	Mostly intact	Orientation survey
18	Aihole, Karnataka	Chamber burials, dolmens	Mostly intact	Orientation surveys
19	Bachinagudda, Karnataka	Chamber burials	Mostly intact	Orientation surveys
20	Hanamsagar,	Avenue	Slight	Partial survey

	Karnataka		disturbance	
21	Kyaddigeri, Karnataka	Chamber burials	Destroyed	Reconnaissance
22	Chik Benakal, Karnataka	Chamber burials	Disturbed	Orientation surveys
23	Vibhutihalli, Karnataka	Avenue	Mostly intact	Surveyed
24	Bheemarayanagudi, Karnataka	Avenue?	Severely disturbed	Partial survey
25	Gudde Maradi, Karnataka	Menhirs	Destroyed	Reconnaissance
26	Konaje Kallu, Karnataka	Dolmens	Disturbed, 2 mostly intact	Reconnaissance
27	Kakkunje, Karnataka	Dolmens	Disturbed, 2 mostly intact	Reconnaissance
28	Rajan Koluru, Karnataka	Dolmens	Disturbed, some mostly intact	Orientation surveys
29	Aaraga Gate, Karnataka	Avenue?	Disturbed	New discovery, partially surveyed
30	Vadakkipatti, TN	Boulder-circle	Mostly intact	Comparison
31	Junapani, Maharashtra	Cairns, boulder circles, pit burials	Mostly intact	Reconnaissance, comparison
32	Nagbhid, Maharashtra	Avenue?	Disturbed	Reconnaissance, comparison, partial survey
33	Champa, Maharashtra	Boulder circles	Mostly intact	Reconnaissance

Note: - * indicates sites visited more than once

- Sites numbered 11-17 are all in Thrissur district of Kerala and are within a few kilometres of each other. They are listed separately because they are distinct enough not to be

lumped together as one site. Similarly, Aihole (18) and Bachinagudda (21) are close by to each other and Bheemarayanagudi (24) is close to Vibhutihalli (23), but are distinct enough to merit being listed as different sites.

4.4.1 Astronomy in megaliths: It was recognized that there may be two ways of approaching the identification of astronomical knowledge as codified in the form and design of megalithic monuments:

i. **Identification of structures that possibly incorporate the knowledge of astronomy among its builders in its conception and design:** A simple alignment to the cardinal points could fall into this category – it indicates that the builders knew enough astronomy to determine the cardinal directions. The very existence of a large number of structures aligned to the cardinal points implies a degree of planning, observation and measurement (Norris and Hamacher 2011). Thus the orientation studies of dolmens, chamber burials, avenues etc. were analysed to determine this, provided that there were enough monuments at a given site to statistically analyse this. Furthermore, orientations of tombs, memorials and other monuments were analysed to see whether they fell within the swathe of sunrise/sunset for the extant latitude. Thus, it could be determined whether they were intended to face the rising or setting sun on any day of the year.

ii. **Identification of structures that were possibly used to acquire and further astronomical knowledge:** These could be structures that were meant to observe celestial objects and infer information about cosmic cycles. This could be something as simple as a gnomon or an arrangement of stones/menhirs to form a calendar device. Several avenue sites were potential candidates for this category. The sites at Vibhutihalli, Hanamsagar, Nilaskal and Byse were selected as candidate sites with high potential. However, Hanamsagar could not be surveyed due to its relatively remote location and the magnitude of the monument making it difficult to survey in the given constraints of time and resources.

Of course, it is possible that structures such as described in (ii) might not exist; it could well be that observations may have been made with wooden posts or maybe smaller instruments, but we are testing the possibility that stone monuments were also constructed and used for calendrical

time-keeping. Also, we have to be open to the possibility that (i) and (ii) do not represent classes with mutual exclusivity – there might be combinations of the two also. Therefore investigations of all classes of megalithic structures have to be approached with these possibilities in mind.

4.4.2 Astronomical sightlines at avenue sites: After analysis of orientation and other data from all surveyed sites, sites at Nilaskal, Byse, Hanamsagar and Vibhutihalli were selected for detailed investigation for alignment studies. However, the site at Hanamsagar could not be surveyed due to the large area covered and the relative remoteness of the site. During one of the follow-up site visits, it was observed that several pairs of menhirs were framing the setting sun on the local horizon during winter solstice at Nilaskal. Detailed surveys of Nilaskal and also Byse, which seemed to have similar characteristics, were undertaken. At Nilaskal, where the land slopes gently up towards the west, topographic survey was also undertaken. The orientation of each standing menhir at both sites were measured and it was seen that the individual menhirs at both sites are oriented mostly north-south. The sightlines between menhirs at each site were studied and it was found that there are large numbers of sightlines between menhirs that are aligned to the rising and setting sun during both summer and winter solstices. Byse appears to have intentional sightlines to the rising and setting moon during major and minor standstill lunistices too, though this could not be proved definitively. The observed sightlines were tested statistically and using other features as indicators. The observed sightlines were also tested for viability using topographic analysis as well as verification at site – they were tested for visibility of backsight from foresight as well as for view of observed phenomenon on horizon from inferred station points. Vibhutihalli was also surveyed as a case example of a known avenue site for comparison with Nilaskal and Byse.

4.4.3 Preferred orientation patterns at sepulchral sites: Orientation data was obtained at several sepulchral sites, for all monuments at those sites. The preferred patterns of orientational preferences were obtained from this data for monuments at Aihole, Bachinagudda, Bandipur, a sample of the large number of monuments at Hire Benakal, Chik Benakal, Konaje Kallu, Kakkunje and Rajan Koluru in Karnataka as well as the sites at Thrissur, Kerala. For the Kudakkals at two sites at Thrissur too orientation data were taken for the lines of joinery as will be explained in the next section on study areas and methods.

4.4.4 Stylistic evaluation and possible chronology as deduced from the refinement of working, components, form and design: This investigation involved the study of different types of megalithic monuments at various sites. Chamber burials/dolmens were studied at Brahmagiri, Chikel Chetti, Hire Benkal, Aihole, Bachinagudda, Chik Benakal, Konaje Kallu, Kakkunje and Rajan Koluru in Karnataka and at Marayoor in Kerala. Rock-cut burials were studied at five sites in Thrissur, Kerala, too. Avenue sites were studied at Vibhutihalli, Bheemarayanagudi, Hanamsagar, Nilaskal, Byse, Hergal, Mumbaru and Aaraga Gate. Using innovations and improvements in design for structural stability, improvements or refinement in stone-working skills and development of embellishments, an attempt at relative dating by stylistic evaluation was made. This, however, can be verified only after a proper chronological framework for megaliths is evolved with suitable dating techniques in the future.

At large, complex and most probably composite sites like Hire Benakal, which were most likely in use for several generations, it is possible to see several classes of monuments which reflect differing approaches to design and construction. Not too many megalithic sites on the subcontinent have this richness and diversity and for that reason alone, Hire Benakal is a very important site in the study of Indian megaliths.

From all the above studies and analyses, conclusions were drawn about the design and layout of megalithic monuments and the astronomical knowledge codified in these. These results and discussions are presented in Chapter 6.

4.5 Study areas: After a survey of the available literature on megaliths and discussions with experts who have worked in this field, it was decided to make a shortlist of monuments to be studied. The shortlist had to reflect the representation of all the broad typologies of megaliths – both sepulchral as well as non-sepulchral. Taking into consideration practical aspects such as travel time to sites and time to be spent on measurements, survey etc. it was decided to confine the list to a small region that reflected all the existing diverse forms of megaliths. It was also decided to take up a smaller number of sites in vastly different geographical regions as comparison sites.

The sites to be studied were mostly in Karnataka and Kerala. One comparison site was studied in Tamilnadu, three in Vidarbha region, Maharashtra and one in Kashmir Valley, Jammu and Kashmir.

Broadly, the areas studied in Karnataka can be divided into two regions – north Karnataka and south coastal Karnataka. In north Karnataka, the sites studied were Brahmagiri, Hire Benakal, Onake Kindi, Aihole, Bachinagudda, Hanamsagar, Kyaddigeri, Chik Benakal, Vibhutihalli, Bheemarayanagudi and Rajan Koluru. In south coastal Karnataka, the sites studied were Nilaskal, Byse, Hergal, Mumbaru, Gudde Maradi, Konaje Kallu, Kakkunje and Aaraga Gate. One more site in Karnataka – Chikel Chetti was studied near the Bandipur Wildlife Sanctuary close to the border with Kerala and Tamilnadu. The sites studied in Kerala were the Thrissur group of sites and one at Marayoor, near the well-known hill station of Munnar. The site studied in Tamilnadu is a boulder circle site at Vadakkippatti in Thanjavur district. The sites studied in the Vidarbha region are all near Nagpur – Junapani and Champa being boulder circle and cairn circle sites and Nagbhid being a menhirs site, probably an avenue too.

4.5.1 The sites of north Karnataka: The sites of north Karnataka are located in a region rich in terms of topography and climate (Sundara 1975, p. 10). There are chains of hills of various rock types and hills and valleys of each type of rock have widely differing character. Areas in different parts of this region – which extends from 14^o 20’ to 17^o 30’N in latitude and 74^o 30’ to 77^o 30’E in longitude, are endowed with varying amounts of rainfall annually, thus creating even more diversity in character. Part of this region and some of its surrounding regions – viz. districts of Raichur, Bellary and Chitradurga as well as Anantapur and Kurnool in Andhra Pradesh formed one of the largest nuclei of megalithic culture in the Deccan.

a. Brahmagiri: Brahmagiri is the celebrated site excavated by Wheeler (1948) wherein he laid the foundations of stratigraphy in the study of prehistoric and protohistoric south India and established the chronology, ceramic typology and even the basic historical understandings of South Indian prehistory (Morrison 2005). It is a granitic outcrop rising about 600feet above the plain, within Molakalmuru Taluk of the Chitradurga District of Karnataka State. The megalithic site is located close to Asoka Siddapura – the site of two minor rock edicts of Emperor Asoka, known as *Isila* during Asoka’s reign. Wheeler’s excavations of 1947 established a sequence of three cultures at the habitation site near the megaliths – a Neolithic-Chalcolithic Period I,

followed by the megalithic Period II and a Period III Early Historical culture which he called the Andhra culture, the last of which was datable due to the recovery of evidence of Roman contacts from this level (Rao 1972).

The burials during the Neolithic were within the habitation area – infants were interred in urns and adults were buried in pits in extended position. During the megalithic period, cist and pit burials with surface markers of boulder circles emerged. It was Krishna who first observed these hundreds of cist circles, many of them cist graves made of thin slabs with or without capstones and boulder circles around them (Rao 1972, p. 153). Wheeler excavated ten megaliths – both pit (4 nos.) and cist circles (6 nos.) in 1947. Recently, the re-analysis of samples of wood collected by Wheeler by Morrison (2005) gave an overall range of between 2140-1940AD, which suggests that the practice of erecting megaliths may have begun during the South Indian Neolithic itself.

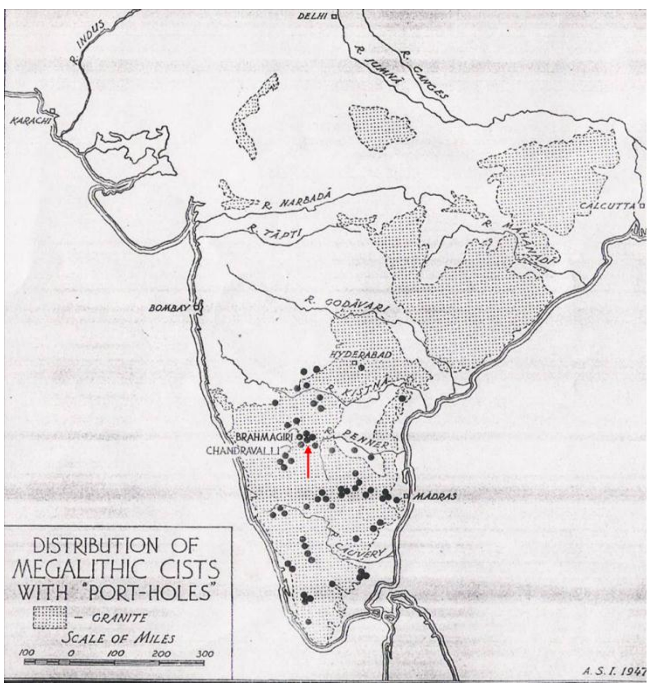


Figure 4.2: Map showing location of Brahmagiri (Wheeler 1948)

Brahmagiri was visited because it is one of the defining sites in the study of megaliths in peninsular India. It is also labelled as a type-site in the sense that the term "Brahmagiri style cists" with port-holes has become a standard for comparison of construction techniques and form. Our visit to Brahmagiri revealed severely disturbed megaliths in the areas studied by Wheeler, with stones of the boulder circles badly disturbed, capstones missing and orthostats

broken and disturbed in many cases, though a few unexcavated megaliths also appeared relatively intact. The on-site observations are discussed in the next chapter.

b. Hire Benakal: Hire Benakal (15^{o} 25' 33"N, 76^{o} 27' 24"E) is probably the most important site in the study of megalithic cultures in south India. The site which is set in the midst of low rocky hills of granite-gneiss, is one of the largest megalithic sites in India both in terms of extent and number of structures, was first noticed by Keis as described in Meadows-Taylor (1941). The site can be approached from the old Hire Benakal town, which is accessed from the highway connecting Gangawati to Koppala and is about 55km from Hospet – the nearest large town. The hill where the megaliths are located is known as "*Moriyare Gudda*" (Hill of the Dwarves) locally and has to be approached on foot. It is believed that a dwarf race endowed with superhuman strength erected the structures – especially the port-holed dolmens and dolmenoid cists as their residences.

Figure 4.3: Showing a satellite picture of the location of the megalithic site of Hire Benakal and the rock art site of Chitra Gund

The megaliths, which consist of a rich repertoire of forms varying from the very simple to highly complex (described in detail in the next chapter), are scattered in three distinct groups, separated by rocky outcrops, on the saddle of a hill. A habitation site was observed by Sundara (1975) less than a km from the cemetery. Surveying the entire group was an exercise beyond the scope of this study aimed at several sites, so the survey was confined to marking the extent of the groups and studying a representative sample of all the typologies.

Hire Benakal seems to be the largest among at least ten other smaller groups of megalithic structures at distances varying from 3 to 35km from it, including Chik Benakal discussed below. There are also at least two rock art sites nearby. Chitra Gund (15^{o} 25’ 20”N, 76^{o} 27’ 10”, see Fig. 4.3) is on the same hill as the megaliths, whereas Onake Kindi is a few km away to the south-east, closer to Anegondi across the Tungabhadra from the World Heritage Site of Hampi – the capital of the erstwhile Vijayanagara Empire.

c. Onake Kindi: Onake Kindi (15^{o} 22’ 09”N, 76^{o} 28’ 32”E, see Fig.4.5) is 40km by road from Hire Benakal, and is believed to have been used by the same culture that produced the megalithic monuments at Hire Benakal. The site is approached from the road connecting Anegondi from Hospet. The entry leads through a narrow gap between boulder strewn hills to an amphitheatre of low rocky outcrops, among which at five places within the amphitheatre and two places outside, paintings in red ochre and white pigments can be seen. The enigmatic representation of a megalith described in Chapter 3 (Fig. 3.14) is at Onake Kindi. The paintings will be described in detail in the next chapter.

d. Chik Benakal: The megalithic site of Chik Benakal (15^{o} 24’ 25”N, 76^{o} 25’ 48”E) is situated about 5km east of Hire Benakal and is across a major ridge in the range of hills and is approached from the village of Chik Benakal via another ancient site called *Maleyammana Ooti*, which seems to be an ancient ritual site associated with a small rivulet. Our visit turned up 15 port-holed dolmenoid cists of the Hire Benakal Eastern group type with almost all of them showing signs of vandalism and heavily disturbed.

e. Aihole: The megalithic site at Meguti Hill (16^{o} 00’49”N, 75^{o} 53’ 12”E) near Aihole is situated on the flat sandstone hilltop between the well-known Meguti Jain Temple (642AD) and the rock-

cut Jain cave to the south (see Fig.4.4). The megaliths, which consist of port-holed dolmens and other types, will be discussed in the next chapter.

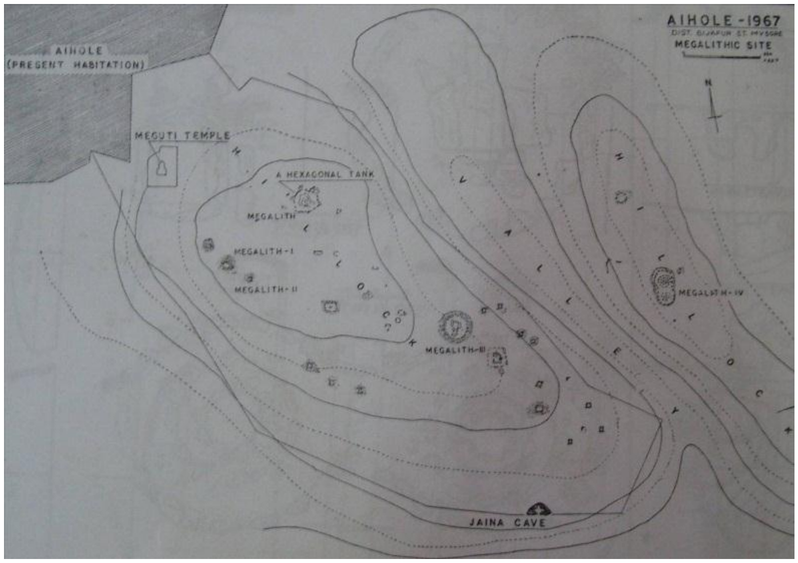


Figure 4.4: Aihole and Kyaddigeri (Sundara 1975)

f. Kyaddigeri: The megalithic site of Kyaddigeri, which was reported by Sundara (1975) as extension of the Meguti Hill site, on a hill across a valley to the east, is approached by a road which passes in front of the rock-cut Jain cave in the south. However, a visit to the site in January 2008 revealed that all the megaliths (some 60 in number, according to Sundara) had been recently destroyed.

g. Bachinagudda: There are only two megaliths at this site (15^{o} 56’ 53”N, 75^{o} 47’ 57”E), which is near the well-known temple site of Pattadakal, near a hill. The site is approached from the Badami-Pattadakal road and is about 1.5km south of it. The two megaliths were mostly intact.

h. Hanamsagar: Hanamsagar (16^{o} 19’ 31”N, 76^{o} 27’ 05”E, see Fig.4.5), is the largest avenue site in Karnataka. It is east of the well-known town of Badami and north of Hire Benakal. This site, known locally as *Salgal Bayalu* is described by Paddayya (1995) as discovered by the geologist G. Mahadevan in the Shorapur Doab formed by the confluence of the rivers Krishna and Bheema. It is situated among the Kodekal group of granite hills and is surrounded by signs of ancient inhabitations like a Mesolithic site, a Neolithic ashmound, megalithic sites like Rajan Koluru, Hegratgi etc. The monument, which consists of more than 2500 granitic stones arranged

in a specific pattern, is surrounded by a low circle of hills on all sides except the south. Allchin (1956) states that the stones are arranged in a diagonal grid.

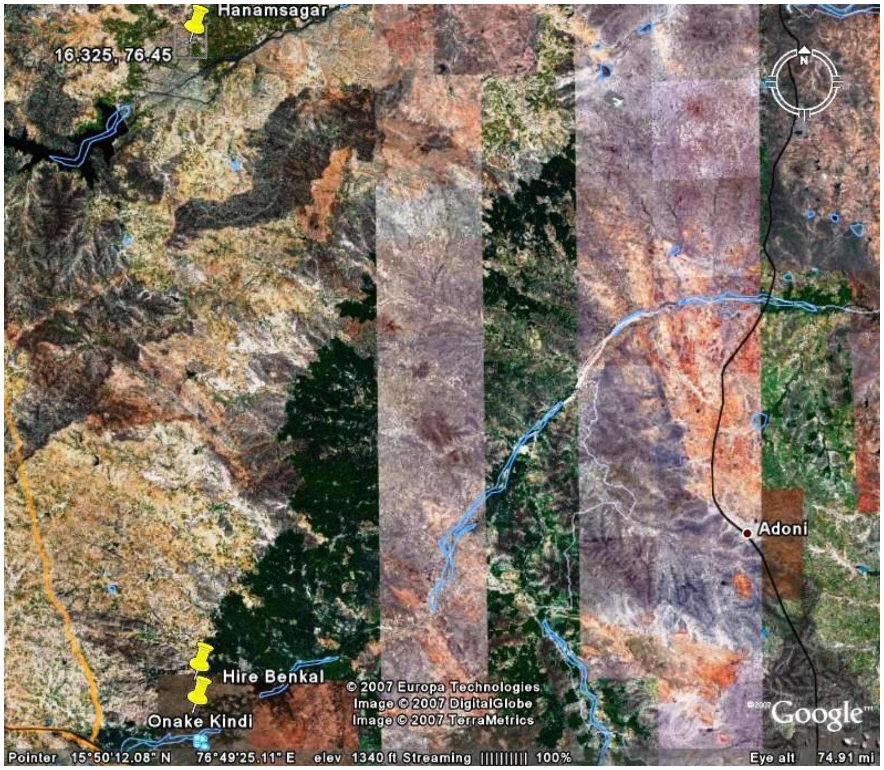


Figure 4.5: Showing location of Hanamsagar with respect to Hire Benakal and Onake Kindi

i. Rajan Koluru: The nearby megalithic site of Rajan Koluru (16^{o} 22' 34"N, 76^{o} 27' 05"E), is situated about 5km north-east of the town of Kodekal and is approached from the Hunasgi-Kodekal road. Sundara (1975) reports nearly 90 limestone megaliths at the site in one group, but our visit in December 2009 showed only 47 megaliths distributed in two non-uniform groups and the remains of some others, the rest being lost to agricultural activities.

j. Vibhutihalli: The well-preserved stone alignment of Vibhutihalli (16^{o} 39' 53"N, 76^{o} 51' 31"E) is about 4kn south of the town of Shahpur on the left (eastern) side of the Shahpur-Surpur road. The alignment, which consists of nearly 1000 stones arranged in a diagonal-grid pattern, is on relatively flat ground roughly a square of 200m sides. The forest department, which has a plantation there, has protected the site very well.

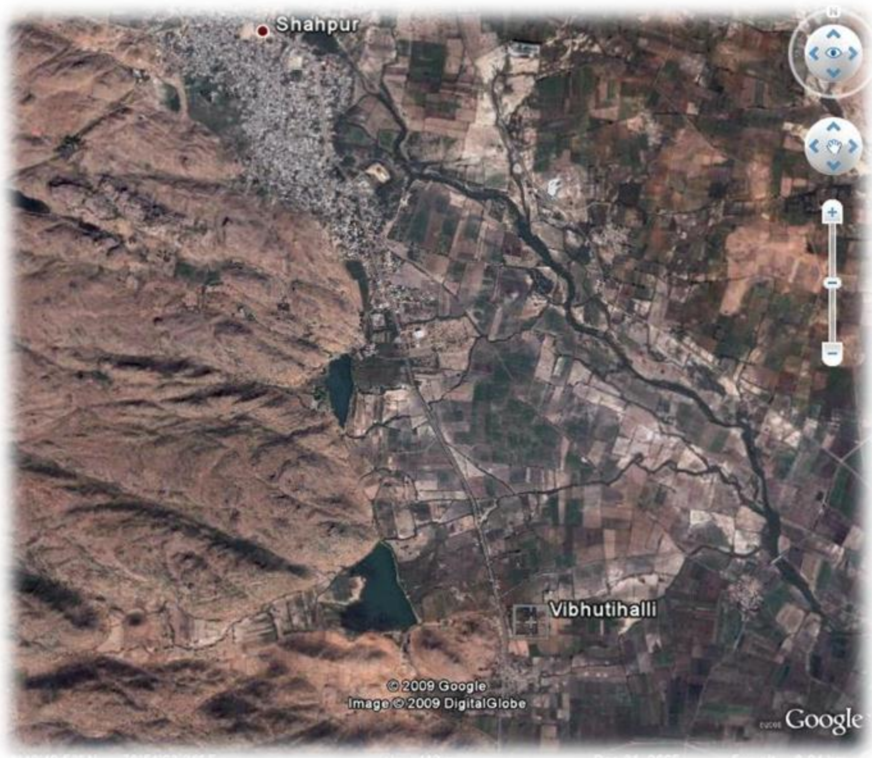


Figure 4.6: Showing location of Vibhutihalli

Figure 4.7: Showing the location of menhir site at Bheemarayanagudi

k. Bheemarayanagudi: This site (16° 43’ 20”N, 76° 47’ 59”E), heavily disturbed now, which has a part of a stone alignment that was probably destroyed during road-building activities, is about 5km west of Shahpur (Fig. 4.7). It consists of 6-7 large undressed boulders and one fallen dressed menhir of granite-gneiss, though Sundara (1975) observed about 16 menhirs, mostly dressed.

4.5.2 The sites of south coastal Karnataka: There are a series of menhir sites in southern coastal Karnataka that were first studied by Sundara (1969, 1975, 2004). Sundara (1975, p. 146) mentions the megaliths at Nilaskal and Gudde Maradi while discussing the occurrence of menhirs south of the Raichur Doab. He lists Brahmagiri and Sanganakallu as having a small number of menhirs and then Nilaskal and Gudde Maradi in Shimoga district of Karnataka. The other three sites of Byse, Hergal and Mumbaru are listed in Sundara (2004). The megalithic site at Aaraga Gate nearby appears to be another of this series of sites. The sites of Udupi district – Konaje Kallu and Kakkunje were also studied.

a. Nilaskal: Nilaskal (13° 46’ 36”, 75° 01’ 09”) lit. “standing stones” in Kannada, is a village in Karimane Taluka located 24km by road south-west of the town of Hosanagara (Fig.4.8). The megalithic site is 8km away from the old town of Nagara, 1km off to the west from the road from Nagara to Udupi. Sundara (1975) noticed about 20 menhirs at the site, presuming many as missing, and also collected some sherds of Neolithic greyish ware pottery of the Maski fabric from a newly cut road trench that ran through the site. Nilaskal is the first Neolithic site to be noticed in the Sharavati river basin near the Western Ghats. Sundara (1975) also mentions that the menhirs of Nilaskal are “erected haphazardly unlike those of Vibhutihalli or North Karnataka.” Our visits have confirmed the presence of at least 100 menhirs at the site, including the broken stumps and remnants of several menhirs. Several others seemed to have been destroyed in the course of construction of a school and private residences in parts of the site.

b. Byse: The site (13° 49’ 45”N, 75° 00’ 43”E) in Byse village is located about 15km south of south-west of Hosanagara. It is off the new road from Nagara to the famous temple town of Kollur. Near the megalithic site, which is on an elevated open patch of land, is a large square plot of land surrounded by fortification walls in stone masonry that are more than 1.5m thick. This area, from which pottery, roof tiles etc. have been found, known locally as *Bungle Gadde* (lit. the field with the bungalow) is believed to have belonged to the Keladi Nayaka dynasty, which ruled

the region from 1499-1763AD. Sundara (2004) reports that he had heard of this site during his explorations at Nilaskal in the 1960's and visited the site in the early 1990's, when he found about a dozen menhirs, of which about six are almost intact, scattered over an area of 2-3 hectares. Two of the stones are under worship.

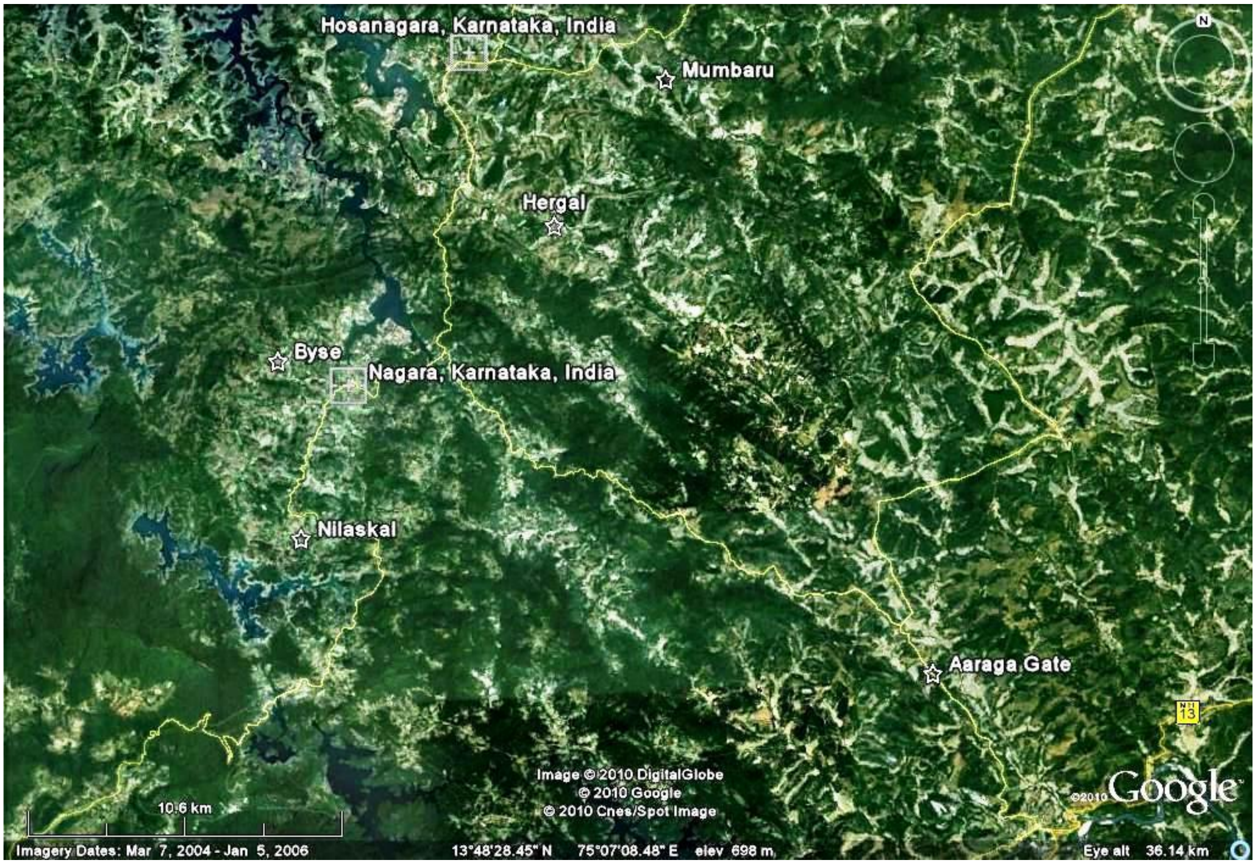


Figure 4.8: Showing the location of Nilaskal, Byse, Hergal, Mumbaru and Aaraga Gate

c. Heragal: The megalithic site at Heragal (13° 52' 24", 75° 06' 3") was also first reported by Sundara (2004) as discovered during his explorations in the region in 2002. Heragal is situated south-east of Hosanagara and is accessed from the town of Jayanagara, via Gorgodu village. Sundara (2004) reports about a dozen menhirs in various states of dilapidation scattered over an area of about 2 hectares. The tallest menhir at the site is worshiped by *Saiva* devotees.

d. Mumbaru: Mumbaru (13° 54' 43", 75° 07.47.3") is a megalithic site, also reported by Sundara (2004), as discovered along with Heragal. Mumbaru (erroneously spelt as "Murumba" in Sundara 2004) is located almost east of Hosanagara and is accessed via a mud road that leads off the road connecting Heragal with Jayanagara at Kuntige. Sundara (2004) reports more than a

dozen menhirs in upright or slanting position. The largest menhir on the site has been enclosed in a shrine and is worshipped.

e. Gudde Maradi: The menhir site at Gudde Maradi (13° 54’ 01”N, 75° 34’ 25”E) was reported by Sundara (1975) as having five menhirs, one of them being 2.4m high, with a cross-section of 1.8m x 0.30m. The site was in a disturbed state even during his study and a visit in the course of the present study showed that all the menhirs had disappeared, presumably due to the activities of a granite crushing unit that is currently functioning at the site.

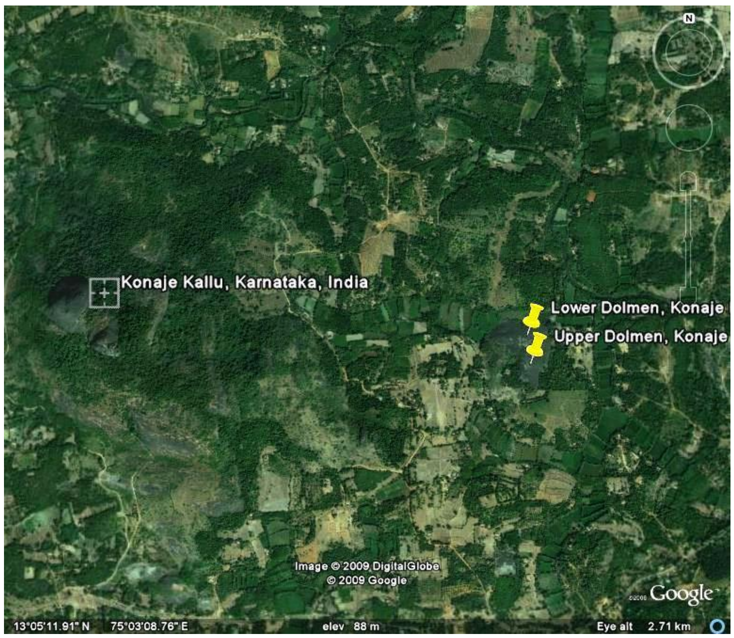


Figure 4.9: Showing location of the megalithic site near Konaje Kallu

f. Konaje Kallu: The site near Konaje Kallu (13° 05’ 07”N, 75° 03’ 30”E) in Udupi district is on a bare rocky hill near the town of Moodubidri, which is well-known for its Jaina monuments. Konaje Kallu is a rocky outcrop near Moodubidri, which has a religious math located up the hill. The megalithic site is located east of this distinct outcrop with twin summits (Fig. 4.9). Two port-holed dolmens are located on the site in good condition with several more in dilapidated state.

g. Kakkunje: This site in Kundapur taluka of Udupi district has two dolmens in partly dilapidated state and several more in severely dilapidated state. The site is accessed from Brahmavar via Kakkunje village and Gavali (which has rock art depicting bulls possibly

belonging to the megalithic period) on the way to Kabbina Ithlu on a mud road. The site is thickly forested with evidence for the quarrying of slabs among rocky patches nearby.

h. Aaraga Gate: The megalithic site at Aaraga Gate (13° 44' 12.9" N, 75° 12' 38.7" E)was discovered in the course of this investigation (Menon, Vahia and Rao, 2011). The site has stumps of eight menhirs in a plantation by the eastern side of the road leading from Tirthahalli to Aaraga. This site seems to be very similar to the site at Heragal with respect to the type of menhirs.

4.5.3 The site at Chikel Chetti: The site at Chikel Chetti (11°39'45"N, 76°43'19"E) was also discovered in the course of this study (Menon, Vahia and Rao, 2011). Chikel Chetti may be reached by a mud road that diverts towards the left from the asphalt road that leads from Bandipur Wildlife Sanctuary in the Chamarajnagar District of Karnataka towards Mudumalai Wildlife Sanctuary in Tamilnadu. The area where the megaliths are situated is flat and plain, with scrub forest nearby. There are low hills visible on the horizon. The megaliths, which consist of 5 exposed cists and 5 undisturbed cairns are located in a flat area roughly 100m E-W x 150m N-S. There is a hill to the north-west of these and a small excavated water body to the west of the megaliths. The local residents refer to the megaliths as *Cholara kallu* (lit. "The stones of the Cholas") and claim that some of the megaliths have disappeared over time.

4.5.4 The Kerala sites:

a. The Thrissur group of sites: Five of the sites visited at Thrissur were rock-cut burials with the two other sites having kudakkals, topikals and other typologies (Rao 1972, Satyamurthy 1992, Mathpal 1998). The rock-cut burials were studied at Eyyal (10° 39' 27"N, 76° 07' 09"E), Chowwannur (10° 39' 22"N, 76° 04' 57"E), Kakkad (10° 39' 42"N, 76° 04' 07"E), Kattankampal (10° 41' 13"N, 76° 02' 21"E) and Kandanasserry (10° 35' 58"N, 76° 04' 57"E), while the site at Ariyannoor (10° 36' 20"N, 76° 05' 07"E) had kudakkals. The site at Kudakkallu Parambu (10° 41' 07"N, 76° 07' 18"E) had kudakkals, topikals and multiple hood-stones as well as a single granite menhir, now fallen.

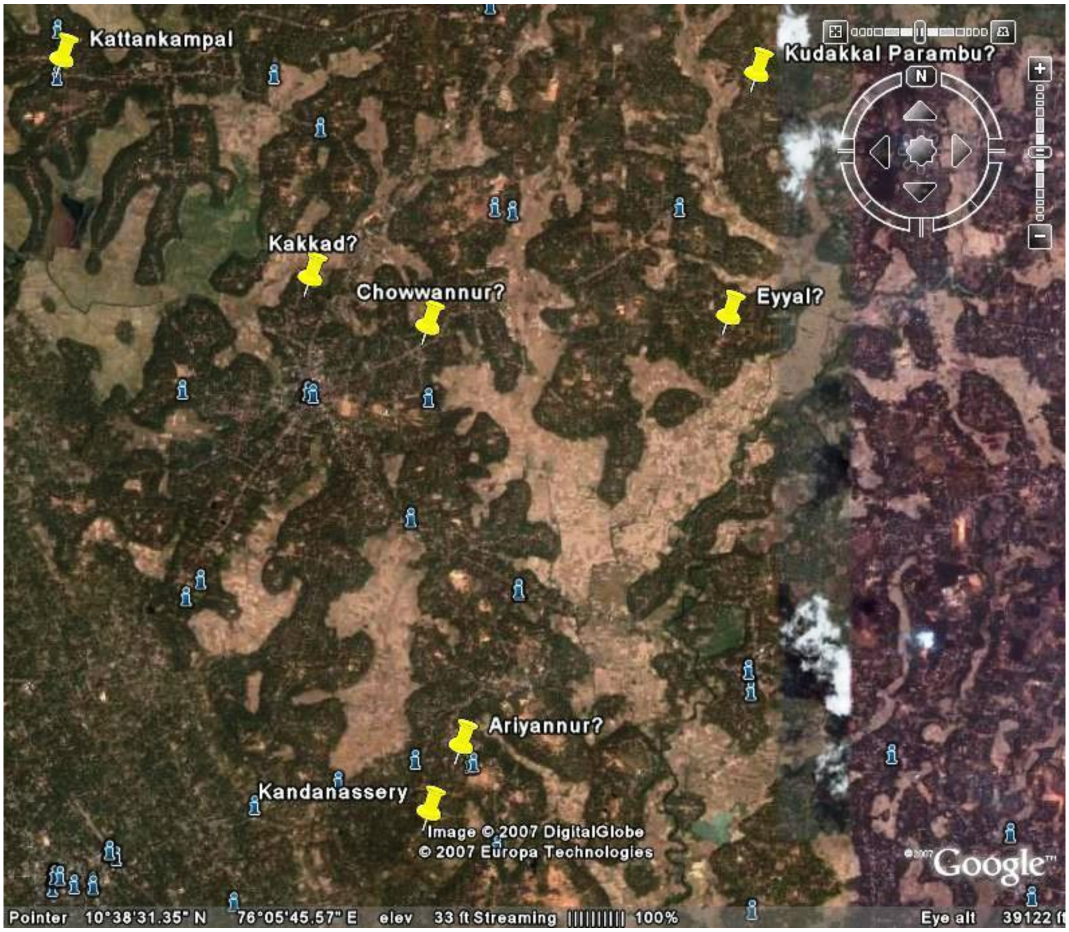


Figure 4.10: Showing the location of the various megalithic sites at Thrissur

The rock-cut cave burial at Eyyal is a double chambered construction with two chambers on adjacent walls of a rectangular excavation into lateritic rock (Rao 1972, p. 49-50). The rock-cut tomb at Chowwannur is a single-chambered cave with a recessed entrance. The rock-cut burial chamber at Kakkad is also single-chambered, with an entrance on the east, and an opening on the roof of the cave. The burial cave at Kattankampal is four-chambered, with two chambers situated adjacent to each other facing east and the others facing north and south into a rectangular excavation. The cave at Kandanasserry is a single-chambered construction with a circular floor and hemispherical dome-shaped roof with an opening above. The site at Kudakkallu Parambu has 3 intact kudakkals and several collapsed ones, with a few topikals and multiple hood stones, all made of laterite. There is also a fallen menhir of granite. The Ariyannoor site has 5 intact kudakkals and a couple of collapsed ones.

b. Marayoor: About 5km east of Marayoor and 50km north of Devikulam in the High Ranges of the Idukki district in Kerala are found several dolmens (Rao 1972, Mathpal 1998). They are known as *Muniyaras* (lit. "the chambers of the ascetics" in Malayalam) locally. More than 70 dolmens were found on various hilltops in the region (Rao 1972). Many have been destroyed since in development activities. During our visit in August 2006, at a hillside near the Kovilkadavu School, about half a dozen dolmens in various states of dilapidation were noted on the crest of the hill and another half-dozen on the flanks of the same hill. Interestingly, several of these have found uses in the current context – a couple as shrines to two different religious faiths and another one as a garbage bin.

4.5.5 The sites of Vidarbha: The region of Vidarbha in the present-day state of Maharashtra is characterised by the topography of the residual hill ranges of the Satpuras, with undulating black soil valleys between them. The plateau is drained by the Wardha and Wainganga valleys. The megaliths of Vidarbha are concentrated in the Bhandara, Nagpur and Chandrapur districts, which are known for their rich mineral deposits, especially raw iron, coal and manganese. The megaliths of Vidarbha are, on statistical analysis, a fairly homogenous group, consisting largely of stone circles, sometimes with cairn filling. However, there are great variations between sites with dolmens and menhirs seen at some sites and even variations in burial practices (Suvrathan 2010).

a. Junapani: Junapani (21° 11' 59"N, 78° 59' 58"E), lit. "stale water" in Marathi, is a single culture megalithic site near and north-west of Nagpur. The megaliths are all boulder circles or cairn circles, several hundred of them distributed in three groups. The site was visited for a comparative study with the southern megaliths.

b. Nagbhid: Nagbhid (20° 34' 37"N, 79° 40' 03"E) is a very different type of Vidarbhan megalithic site. It consists of 16 menhirs or remains of menhirs distributed in a flat field (Fig.4.11). Some of the menhirs are fallen and some are broken stumps and many more are presumably missing, judging by the incursions of buildings and other structures into the area defined by the megaliths. There is a hill on the east but the horizon is visible on the west but for the buildings. Nagbhid offered an excellent opportunity to compare and contrast the menhir sites of Karnataka.

c. Champa: The megalithic site of Champa (20° 58’ 42”N, 79° 11’ 48”E) is an unexcavated field of cairn and stone circles close to Nagbhid. This site which remains to be surveyed contains several hundred megaliths in a fairly intact condition. This site, too, was visited to compare the form and distribution of the megaliths with reference to the southern megaliths.

Figure 4.11: Showing the layout of menhirs at Nagbhid

Figure 4.12: Showing the megalithic site at Burzahoma

4.5.6 The site at Burzahoma, Kashmir Valley: Burzahoma (34° 10' 00"N, 74° 54' 30"E) in the Kashmir Valley is a well-known Neolithic site (Fig.4.12), first noticed by De Terra and Paterson in 1935 (Sharma 2000). In a short excavation, they brought forth a sequence of Neolithic, Megalithic and Early Historic cultures. On the basis of available C14 dates, it is believed that the megalithic phase in Kashmir occurred earlier than the subcontinent. The megalithic culture is believed to have brought rice and iron to the Valley in around 1850BC. The megalithic phase at Burzahoma is represented by the large menhirs, many of them fallen, and they are believed to be commemorative rather than sepulchral.

Our visit in February 2007 was to study the arrangement of the menhirs and formed a comparison to other menhir sites encountered later.

4.5.7 The site at Vadakkipatti, Tamil Nadu: The megalithic site at Vadakkipatti in Tanjavur district of Tamil Nadu was visited briefly to study the form of the boulder circles made of laterite to compare with similar monuments elsewhere.

4.6 Study Methods: The methods used to study the various monuments and the sites of their occurrence will be elaborated below.

4.6.1 Preliminary studies and pre-reconnaissance planning: Once the shortlist of sites was made, each site to be visited was studied from literature wherever available and the route to the site as well as features of the site and surroundings studied on Google Earth maps and Survey of India scale 1:50,000 and 1:25,000 topo-sheets. This was not always possible since the literature available was limited for many sites and even the route and location are not clear for several sites. The geo-co-ordinates given in the above section are all derived from GPS readings taken at the respective sites during this study (except Burzahoma, which was visited before the acquisition of the GPS and is taken from Sharma 2000). For whichever sites that could be observed on Google Earth (henceforth GE) the site features and surroundings as evident from the map were noted and the reconnaissance visit and surveys planned.

4.6.2 Reconnaissance visits and surveys: Reconnaissance visits were mainly to ascertain the continued presence of the monuments at given sites and, if present, the monuments and features were noted and orientations measured. For instance, sites at Kyaddigeri and Gudde Maradi were found to be completely devoid of any megaliths, including traces, and the monument at Konan

Kallu turned out to be non-megalithic, thus ruling out these sites from further studies. No measurements were made at the sites of Brahmagiri, Marayoor and Burzahoma since these sites were visited to get a feel of megalithic sites before the procurement of any equipment. During subsequent reconnaissance visits, the GPS position of each monument was noted using a Garmin GPSmap 60 instrument with a best accuracy of 17 feet. Distance measurements were made using a Leica Disto A3 laser disto-meter and measuring tapes. Orientations were measured using a Lawrence and Mayo prismatic compass with a least count of half-a-degree. However, the nature of the structures being measured have differing accuracies depending on the state of preservation and type of construction and will be discussed in the following section. Most of the sites encountered were either reasonably flat terrain or the monuments being studied did not require the topography to be studied. The monument at Nilaskal, where it was seen that the topography had a crucial role to play in the understanding of the monument, was surveyed using a total station and the monuments placed in their topographic setting. The sizes and vital measurements of important monuments and their components were measured. Finally, the azimuths of observed sightlines at two sites were confirmed using the prismatic compass.

4.6.3 Orientation survey methods: A very crucial measurement involved in this investigation was the measurement of the orientation of megalithic monuments, various components of these and the lines between various monuments or their components. A simple prismatic compass was used for this purpose. Clinometers were not used to find the vertical obstruction due to low hills etc. on the horizon because of the low altitudes involved. All sites were within the tropics except Burzahoma, where, as stated earlier measurements were not involved. However, it is stressed that when azimuths are measured at the site at Burzahoma, a clinometer should be used to evaluate the angular extent of obstruction due to a hill on the east. The basic idea is that, when an azimuth that is measured is compared with the angular extent of sunrise, sunset or any other celestial event calculated for the given latitude, errors would be registered at sufficiently high latitudes if the horizon is obstructed by any feature (say, a hill) which would mean that the azimuth line to the point of actual rise/set on the elevated horizon would be different. This, however, is minimal for the low latitudes encountered at all other sites in this study, since the plane of the diurnal arc of any celestial body for these latitudes is nearly perpendicular to the horizon plane (Fig. 4.13 a, b).

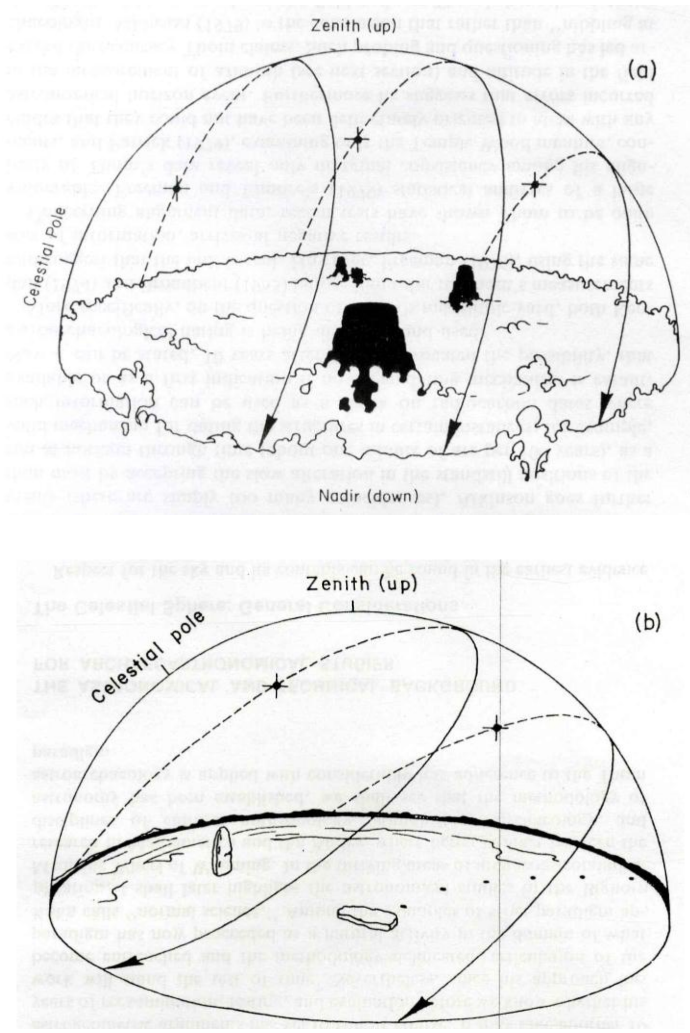


Figure 4.13: Showing diurnal circles of celestial bodies for (a) low latitudes and (b) high latitudes (Aveni 1981)

The prismatic compass has a least count of 0.5^o, however the angular measures obtained by it have an accuracy of $2\text{-}3^o$ at best. This is because of the difficulty in establishing the axis whose azimuth is being established by the measurement (Hoskin 2001). The procedures followed for establishing an axis for the various kinds of monuments encountered in this study is elaborated below.

a. **Dolmens, dolmenoid cists and cists:** These are chambers constructed out of stone slabs. Though rectangular, they are seldom constructed to an accuracy of a few cm. Thus, establishing the axis of the monument to better than $2\text{-}3^o$ is not possible. During this study the orientation of the long axes of the rectangular chambers of these monuments

were measured (Fig. 4.14). If a porthole was present, the direction of the slab containing the porthole was deemed to be the direction faced by the monument.

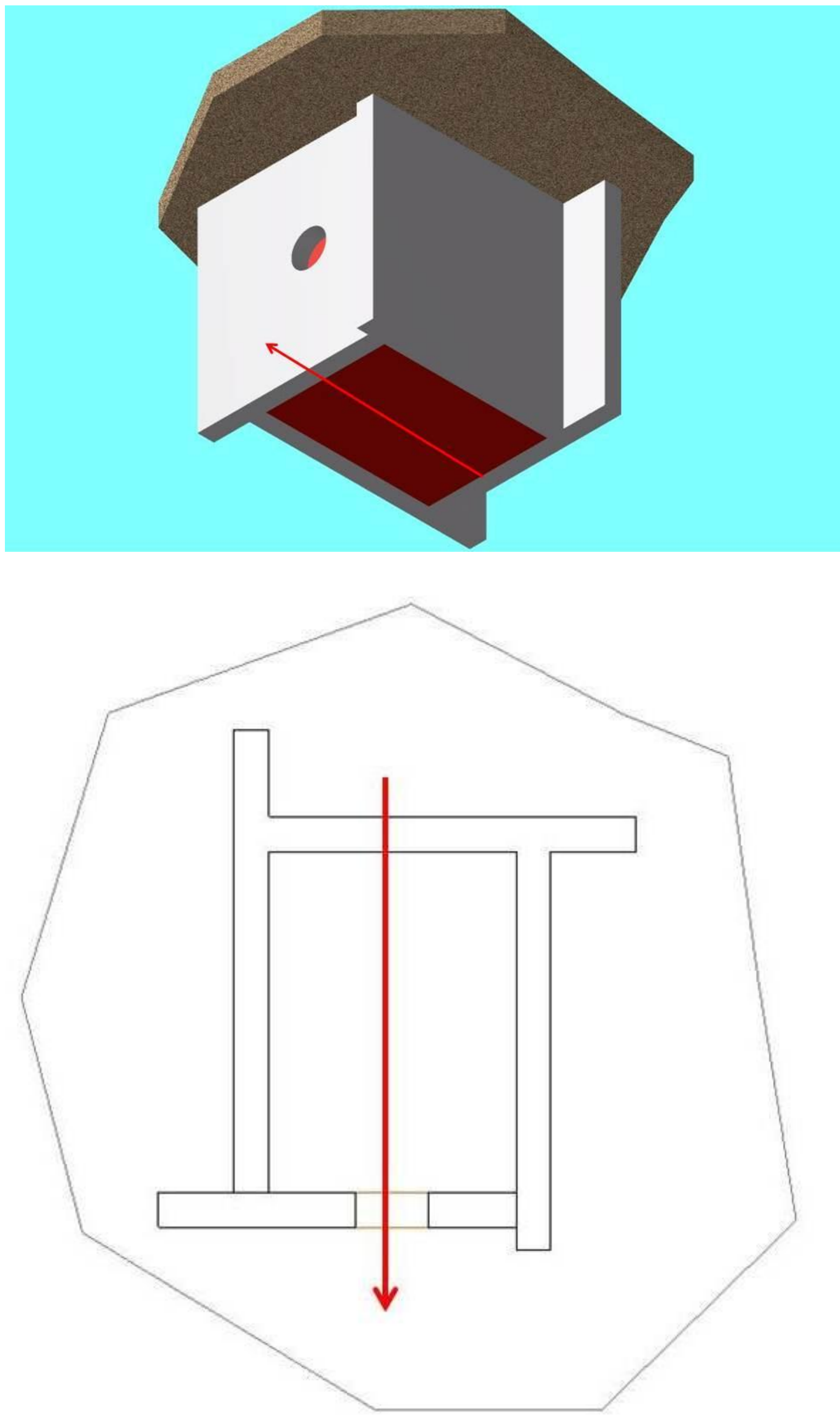


Figure 4.14: Measuring the orientation of a dolmen

A ranging rod is placed at the centre of the rear wall of the chamber (as measured inside) and another placed at the centre of the front wall and the azimuth for this line is measured. Care is taken to avoid magnetic anomalies by taking the reverse bearing of this line (it should be 180^o + the forward bearing observed).

b. **Rock cut burial caves:** The measurement of the axes of rock-cut tombs is a tricky proposition, with the ambiguities in determining the axis sometimes being very difficult. However, the azimuth of the axis, once determined, is measured as indicated in Fig.4.15.

c. **Kudakkals:** The kudakkals of Kerala are made of four clinostats (inclined curved members made of laterite) so that the plan of the arrangement is a circle. The massive hemispherical capstone is balanced atop this combination of four clinostats and has notches in the base to accommodate the tapered ends of these. I measured the orientation of the joints of the clinostats as indicated in Fig. 4.16, to check for any consistency in the way they are put together.

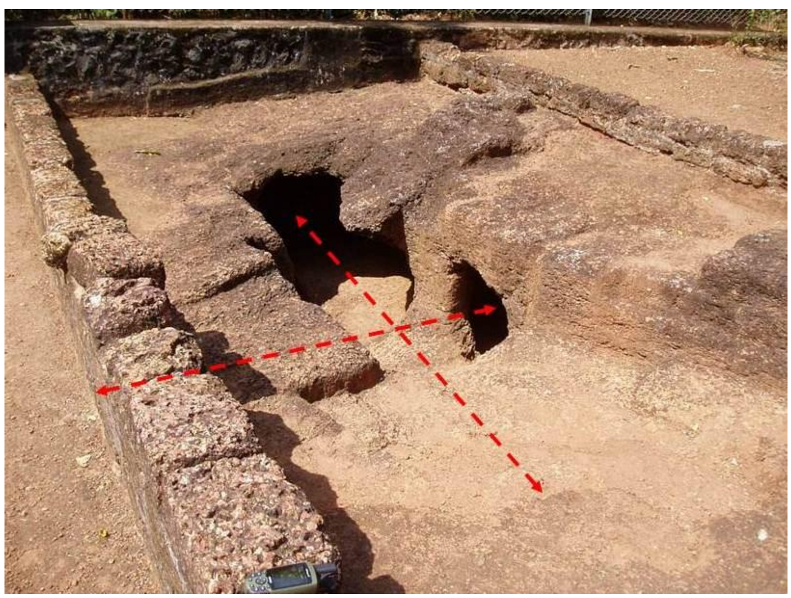


Figure 4.15: Showing the measurement of the orientation of rock-cut tombs

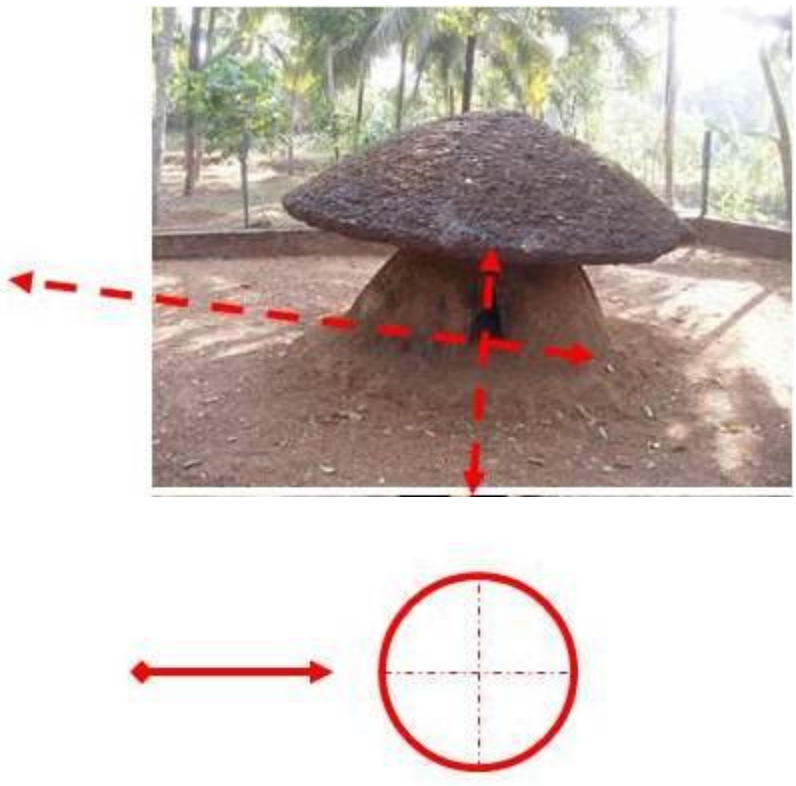


Figure 4.16: Showing the measurement of the orientation of the joints of clinostats in a kudakkal

d. **Individual menhir:** Measuring the orientation of a single menhir is possible only if the menhir is a dressed slab or at least an elongated boulder set on end. For instance, the orientation of a menhir such as those at Vibhutihalli (Fig. 4.17) cannot be measured and thus was not even attempted. However, menhirs such as those at Nilaskal and Byse were measurable. A uniform approach was formulated to measure the orientations of these – the orientations of the eastern faces at the points where they met the ground were measured, whenever possible. This was to avoid the ambiguities that could arise from the inclination of some of the stones. Also, since the stones were roughly 25-40cm thick, inconsistencies can arise if the orientations other than that of the points on the same face of the menhirs are measured. The orientations were measured by placing ranging rods on the far ends of the same face of the stone (Fig. 4.18) and measuring the azimuth of that line with the prismatic compass (Fig. 4.19).

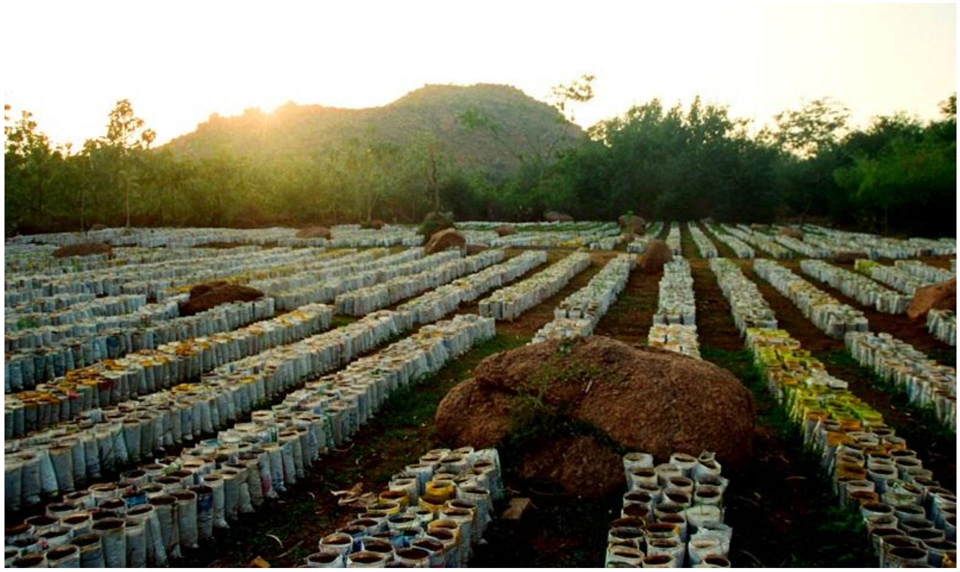


Figure 4.17: Showing the menhirs of Vibhutihalli – orientation measurement is not possible for individual stones

Figure 4.18: Showing the placement of rods for measurement of orientation of a menhir at Nilaskal

Figure 4.19: Showing recording of the azimuth of a single menhir at Nilaskal

e. **Alignments and avenues:** For alignments and avenues, a different method was used for the type of alignment/avenue encountered. The alignments at Vibhutihalli and Hanamsagar consist of field boulders rolled down from the nearby hills and manoeuvred into position in a definite pattern. The accuracy of lines from one boulder to the next does not yield much information and are quite variable. The boulders seem to be distributed about a "best-fit line" whose orientation can be obtained by measuring the orientation of the best-fit line for all the boulders that are visible from one station point of the prismatic compass. The summary of such measurements is seen in Fig.4.20 where the main measurements for the alignment at Hanamsagar are depicted. The more the number of boulders that can be included in each measurement, the more accurate would be the observations. As will be discussed in the next chapter, the measurements at Hanamsagar throws into dispute the accepted form of the alignment at Hanamsagar. For the alignments at Nilaskal and Byse, the bearings of each edge of one menhir from each edge of others were taken with the prismatic compass and the distance along each bearing measured with the disto-meter. The bearings of lines from the centre of each menhir to the centres of others were also taken (Fig. 4.21).

At Nilaskal, since the topography was deemed to be crucial to understanding of the site as a whole, as will be discussed in the next chapter, a total station survey was undertaken and the results compared with the prismatic compass survey and Google Earth maps taking into account major features.

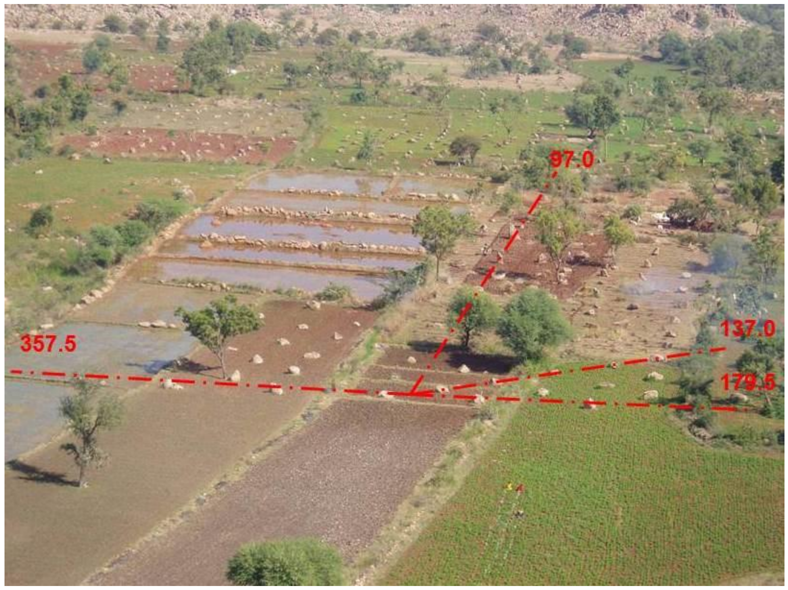


Figure 4.20: Showing the measurement of alignments at Hanamsagar

Figure 4.21: Showing the measurement of azimuth of a sightline at Nilaskal

Of course, all bearings obtained with the prismatic compass are with respect to the magnetic north, and is not with respect to the geographic north – which is the true reference frame to

compare with when dealing with the diurnal motions of celestial objects. Hence all bearings were corrected for the true geographic directions as shown in Fig.4.22. The magnetic declination (that is, the angular difference between the true and magnetic north point) was obtained for the date of survey for each site and the necessary corrections applied.

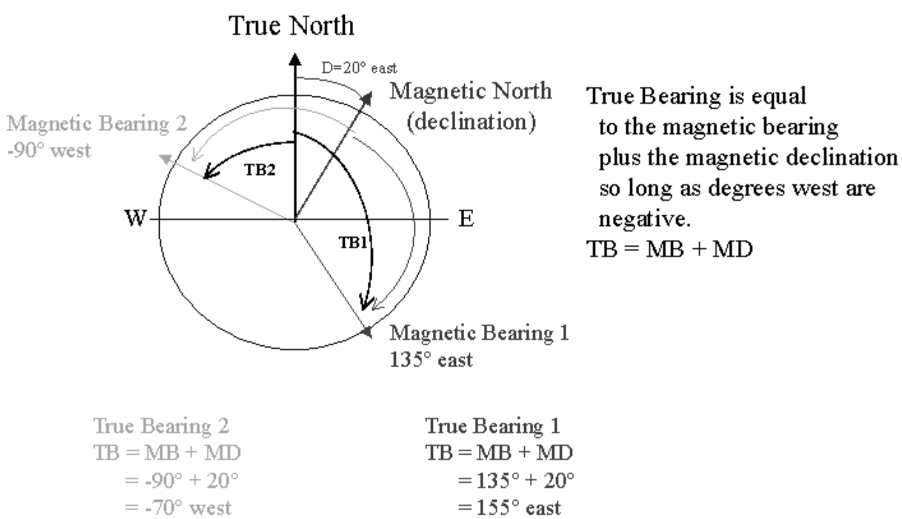


Figure 4.22: Showing the correction for obtaining true azimuth from magnetic azimuth given by the magnetic compass

The obtained azimuths were tested for sightlines to solar and lunar rise/set points for specific dates like the equinoxes, solstice, zenith passage etc. on the local horizon. Stellar sightlines were not tested because, given the datelines in archaeology and the number of bright (first magnitude) stars in the night sky, it would be possible to fit some star or the other to any given sightline (Ruggles, *Pers. Comm.*).

The observed sightlines corresponding to astronomical targets were first validated on field for topographical and other viability; then analysed statistically and otherwise for validity. Features of monuments and components were examined for possible astronomical use. The results of all surveys and these other examinations are laid out in detail in the next chapter.

Chapter 5: Data and analysis

The descriptions of individual sites, monuments and their surroundings as observed during this study, including the state of disturbance, along with survey data from these sites, tabulation of important features recorded and summaries of orientation data recorded, if any, will be presented in this chapter.

5.1 Brahmagiri: Brahmagiri was the first megalithic site to be visited, before the equipment for surveys etc. was procured. The megalithic site at Brahmagiri is stretched out on the plains to the east of a low granite outcrop (Fig. 5.1) in Molakalmuru Taluka of Chitradurga district in Karnataka.

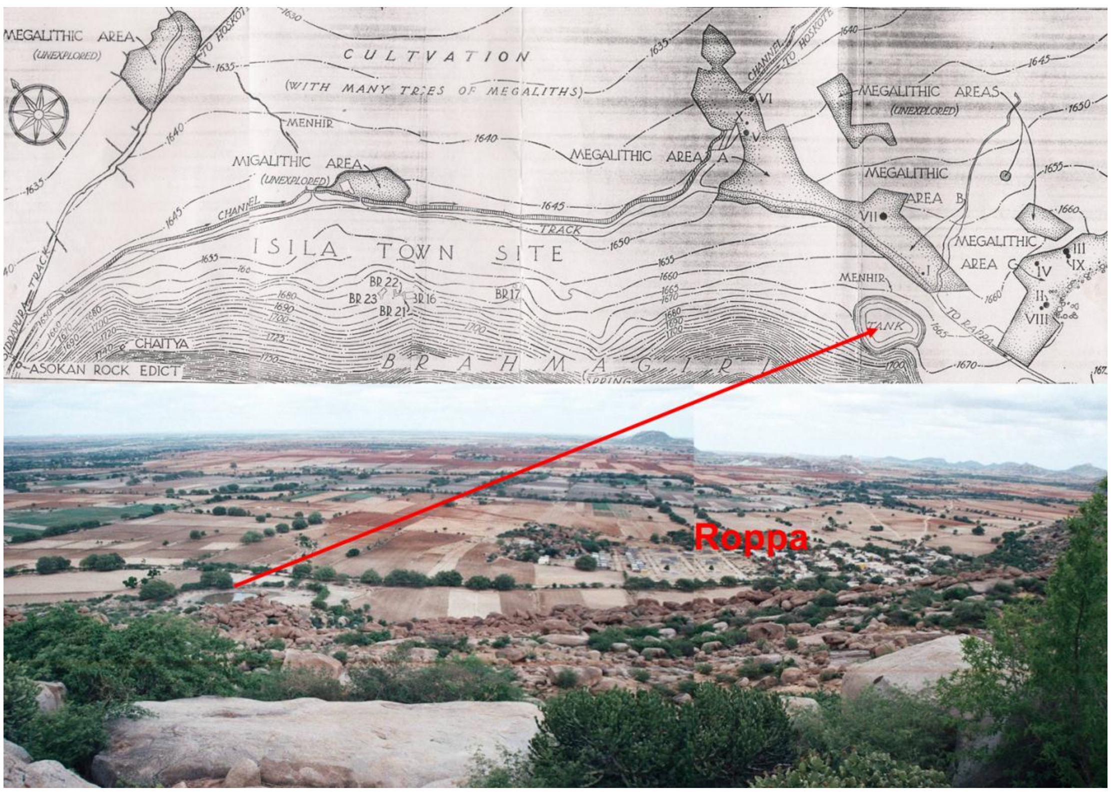


Figure 5.1: Showing the spread of the megalithic sites of Wheeler 1948 (top) as seen from the hill during the visit for this study

The actual sites were found to be heavily disturbed, with many boulder circles disrupted (Fig. 5.2) and slabs of cists used for construction purposes. Capstones of cists were missing and the site seemed in a general state of severe disturbance. However, towards the end of our visit, some

megaliths, such as shown in Fig. 5.3 (which seems to be a boulder circle with a headstone), were spotted that seemed to be minimally disturbed. A thorough survey of Brahmagiri is required to take inventory of undisturbed megaliths and they need to be protected from further vandalism. For this study, no data (except for stylistic comparison) was obtained from the Brahmagiri site.

Figure 5.2: Showing displaced stones of boulder circles near cists at Brahmagiri

Figure 5.3: Showing an apparently undisturbed megalith at Brahmagiri

5.2 Marayoor: The site at Marayoor (10^o 14' 52"N, 77^o 10' 30"E) also was visited before the procurement of survey equipment. These sites were visited to get a feel for the nature of conditions at megalithic sites in general, for planning further field trips and surveys at megalithic sites. The dolmens of Marayoor are spread out over several hills, two of which, near Kovilkadavu, were visited. The dolmens on the hill near the Kovilkadavu School were in a dilapidated state (Fig. 5.4). They were erected at various points on the bare rock of the hill and were in too dilapidated a state to discern if the orthostats were in interlocked positions originally. A dolmen observed at another hilltop near Paisnagar (Fig. 5.5) had sides made of more than one slab and another dolmen (Fig. 5.6) had a U-shaped porthole similar to the Aihole typology. No data other than for stylistic comparison were collected at the sites at Marayoor, too.

Figure 5.4: Showing one of the dolmens on the hill near the Kovilkadavu School

Figure 5.5: Showing the Paisnagar dolmen

Figure 5.6: Showing a Marayoor dolmen with a U-shaped port-hole (Photo: Sridevi Changali)

5.3 Burzahoma: Burzahoma is well known as a Neolithic site, with a later megalithic phase represented by the presence of a few large menhirs. Burzahoma was visited in February 2007, to study one of the few known megalithic sites of the Kashmir Valley to compare with the menhir sites of the subcontinent to be visited later. The portion of the site with the menhirs is to the north-west of the pit-dwellings and is indicated on the satellite map of the site by a large red circle in Fig.5.7. There are about 9 menhirs and what appear to be their remnants, of which only one is standing and the rest are in various states of collapse (Fig. 5.8). The stones, which appear undressed, are over 40cm thick and over 4m tall. The width of the single standing stone is less than 2m. Sharma (2000) makes a conjecture that the stones formed a rough semi-circle when standing, with the opening towards the south-east; however, it is difficult to conclude that from the condition of the remaining stones. The menhirs were held in place originally by rubble packing and were not sepulchral in character (Sharma 2000). During this study, we observed several cup marks on two of the fallen stones (Fig. 5.9), but it was not evident whether the cup marks post-date the collapse of the menhirs.

Though a detailed survey was not made, during this study, a mound (Fig. 5.10) was noticed to the south-east of the menhir complex, which appears to coincide with the southernmost rising of the sun on winter solstice day. However, the presence of a hill in the east makes the observation of sunrise on this date impossible. Another feature to the south-west was noticed on the satellite map. These two features are marked by small red circles in Fig. 5.7. The area having the menhirs

is raised (Fig. 5.8), and it appears that this was done artificially, judging from an exposed section encountered. However, only an excavation with these objectives in mind can verify this.

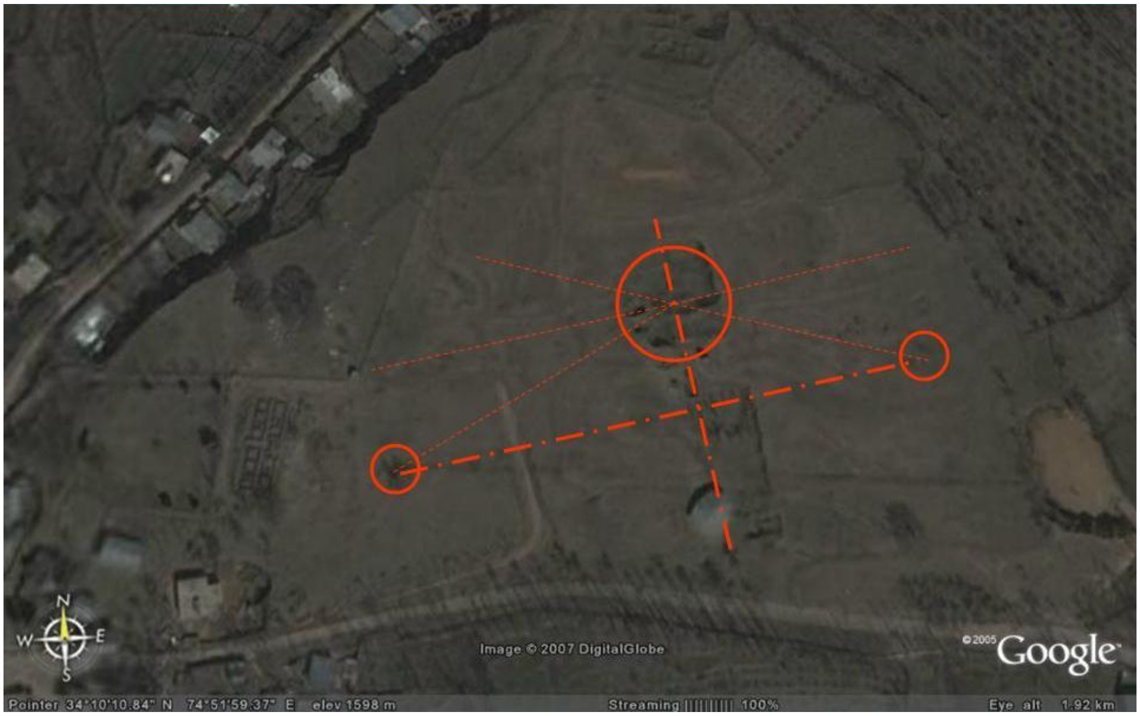


Figure 5.7: Showing the layout of the various structures at Burzahoma

Figure 5.8: A view of the menhirs at Burzahoma from the north-west

Figure 5.9: Cupmarks on one of the fallen menhirs of Burzahoma

Figure 5.10: A mound to the south-east of the menhirs at Burzahoma

No data was collected from Burzahoma also for this study, except stylistic comparisons. Burzahoma and Gurfkral in the Kashmir Valley were excavated with the focus on the Neolithic levels (Sharma 2000) and not much care or attention was given to the megalithic strata. It would be in the best interests of archaeology in India if the remaining 4-5 sites with megalithic menhirs in the Kashmir Valley would be carefully studied.

5.4 Chikel Chetti: The cairns and exposed cists at Chikel Chetti were discovered during a chance visit to a private property near Bandipur in Karnataka, close to the border with Tamil Nadu. The site was visited twice after that and a site plan prepared (Fig. 5.11). The megaliths, which were found in private as well as government land, are in the village of Chikel Chetti. Chikel Chetti may be reached by a mud road that diverts towards the left from the asphalt road that leads from Bandipur Wildlife Sanctuary in the Chamarajnagar District of Karnataka towards Mudumalai Wildlife Sanctuary in Tamil Nadu.

The area where the megaliths are situated is flat and plain, with scrub forest nearby. The geo co-ordinates of the site are: 11°39’45”N, 76°43’19”E. There are low hills visible on the horizon. The megaliths, which consist of 5 exposed cists and 5 undisturbed cairns are located in a flat area roughly 100m E-W x 150m N-S. There is a hill to the north-west of these and a small excavated water body to the west of the megaliths. The local residents refer to the megaliths as *Cholara kallu* (lit. “The stones of the Cholas”) and claim that some of the megaliths have disappeared over time.

The megaliths are either exposed cist burials which are severely disturbed or cairns that are more or less intact.

Cist Burials: The cists are made of granite slab orthostats, roughly 0.10m thick, whose tops are visible above the ground level (see Fig.5.12). The cists, rectangular in shape, are rather small, with the length of the exposed orthostats above the ground varying from 0.33m to 1.42m. Three of the cists have 3 orthostats surviving, one has two remaining orthostats and one has just an orthostat left. Though it is difficult to say for sure with the scanty remnants, it does look that the orthostats were originally meant to interlock in the manner of the Brahmagiri cists (Wheeler 1948). The width of the space enclosed by the orthostats varied from 0.36m to 0.53m. Two of the cists with 3 orthostats were oriented E-W (260° and 285°), with the other oriented N-S (303°).

The cists are obviously highly disturbed, with at least one orthostat missing from all and the contents of the chamber, if any, missing. It is highly likely that capstones were originally present, since two large slabs, some 20cm thick, turned up during the excavation for the foundation of a building nearby. It is impossible to say if there were any portholes in any of the orthostats since none of the cists are intact.

Cairns: The area also has 5 large cairns of various diameters. The cairns are large heaps of stone rubble piled up in a roughly circular layout. The diameters of the cairns are 5.5m, 6.4m, 9.0m, 9.3m and 11.0m. The largest cairn (see Fig. 5.13) has stone slabs driven in on end around its diameter, presumably to contain the large heap of rubble that comprises the cairn. A large slab with chisel marks was found on one of the cairns. However, the chisel marks could be of relatively recent date when someone could have removed a portion of the slab. It is possible that the cairns enclose one or more cist burials beneath the ground. Only excavation can tell us about this. The cairns seem more or less intact and free from vandalism.

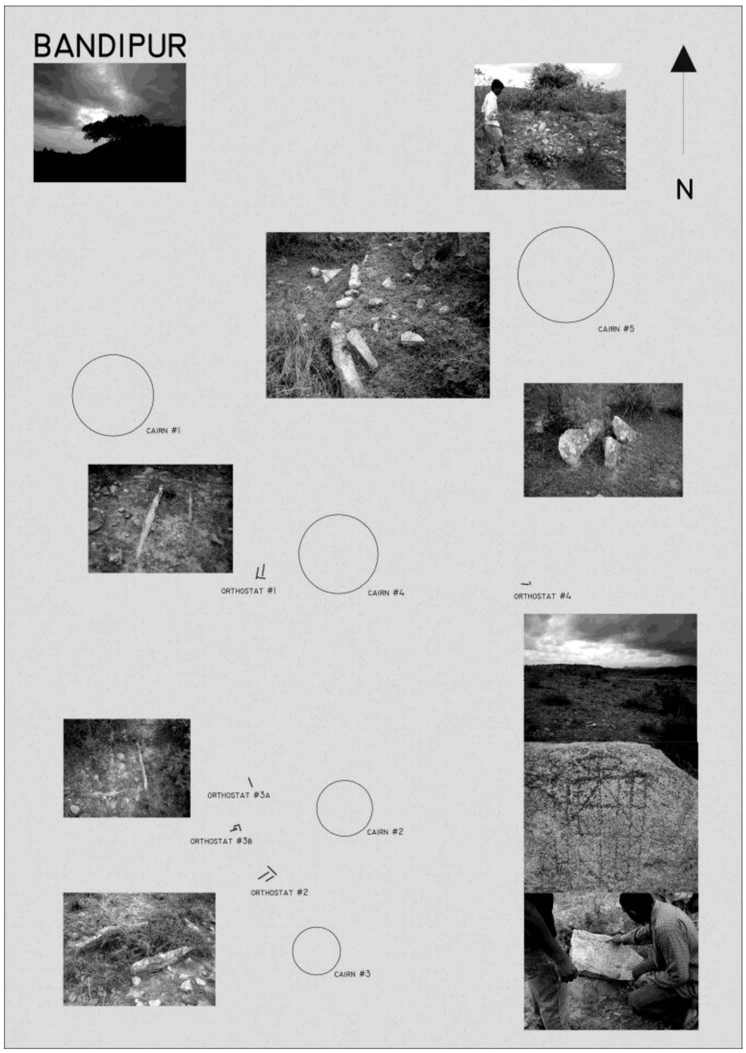


Figure 5.11: Site plan showing layout of megaliths at Chikel Chetti, Bandipur

Figure 5.12: Showing one of the exposed cists at Chikel Chetti

Figure 5.13: A view of the largest cairn at Chikel Chetti

The orientations and sizes of the exposed cists were measured and the diameters of the cairns were also noted, as already mentioned. The summary of orientations of the exposed cists at Chikel Chetti is given below.

Table 5.1: Summary of orientations of exposed cists at Chikel Chetti, Bandipur, Karnataka (Corrected for magnetic declination for Chikel Chetti on date of survey = 2^{o} 2'W changing by 0^{o} 0'/year)

No.	Megalith	Lat-Long	Orientation	Comments
1	Cairn 1	11 39.743 76 43.290		Dia = 9.262m
2	Cist 1	11 39.732 76 43.290	258.5^{o}	3 orthostats visible
3	Cairn 2	11 39.717 76 43.304		Dia = 6.37m
4	Cist 2	11 39.713 76 43.299	301^{o}	Disturbed; 3 orthostats – not at right angles…
5	Cairn 3	11 39.708 76 43.302		Dia = 5.463m
6	Cairn 4	11 39.733 76 43.304		Dia = 9.007m
7	Cairn 5	11 39.750 76 43.319		Dia =10.923m; biggest!
8	Cist 3a	11 39.719 76 43.298	200^{o}	Only 1 (short?) orthostat
9	Cist 3b	11 39.716 76 43.297	283^{o}	3 orthostats visible; 2 stones inside
10	Cist 4	11 39.731 76 43.316	264^{o}	2 orthostats visible; not right angle

5.5 Hire Benakal: This is arguably the most important megalithic site in the whole subcontinent. Though not excavated or studied in the detail it deserves by archaeologists, it seems to have been a large megalithic mortuary complex having a variety of sepulchral/commemorative megalith types. The range of megalithic monuments varies from simple rock-shelter chambers and Irregular Polygonal Chambers to dolmenoid cists and dolmens (Sundara 1975). Though Allchin (1955, p. 99) noticed upwards of 440 megaliths in his study, Sundara (1975, p. 73-75) reports approximately 280 and it was noticed during this study that less than that number survive. The megaliths are distributed in three groups on the saddle of a hill and separated by low granite outcrops. These were termed Western, Central and Eastern groups by Sundara (1975). It was impossible to survey the whole site with the logistical constraints of the present study. Hence, it was decided to get the GPS co-ordinates of the outermost megaliths of each group and determine the extent of the site. The extent of the Western and the Central groups are indicated on a GE

map in Fig. 5.14. Orientation measurements were made for randomly picked megaliths, as summarised in Table 5.2.

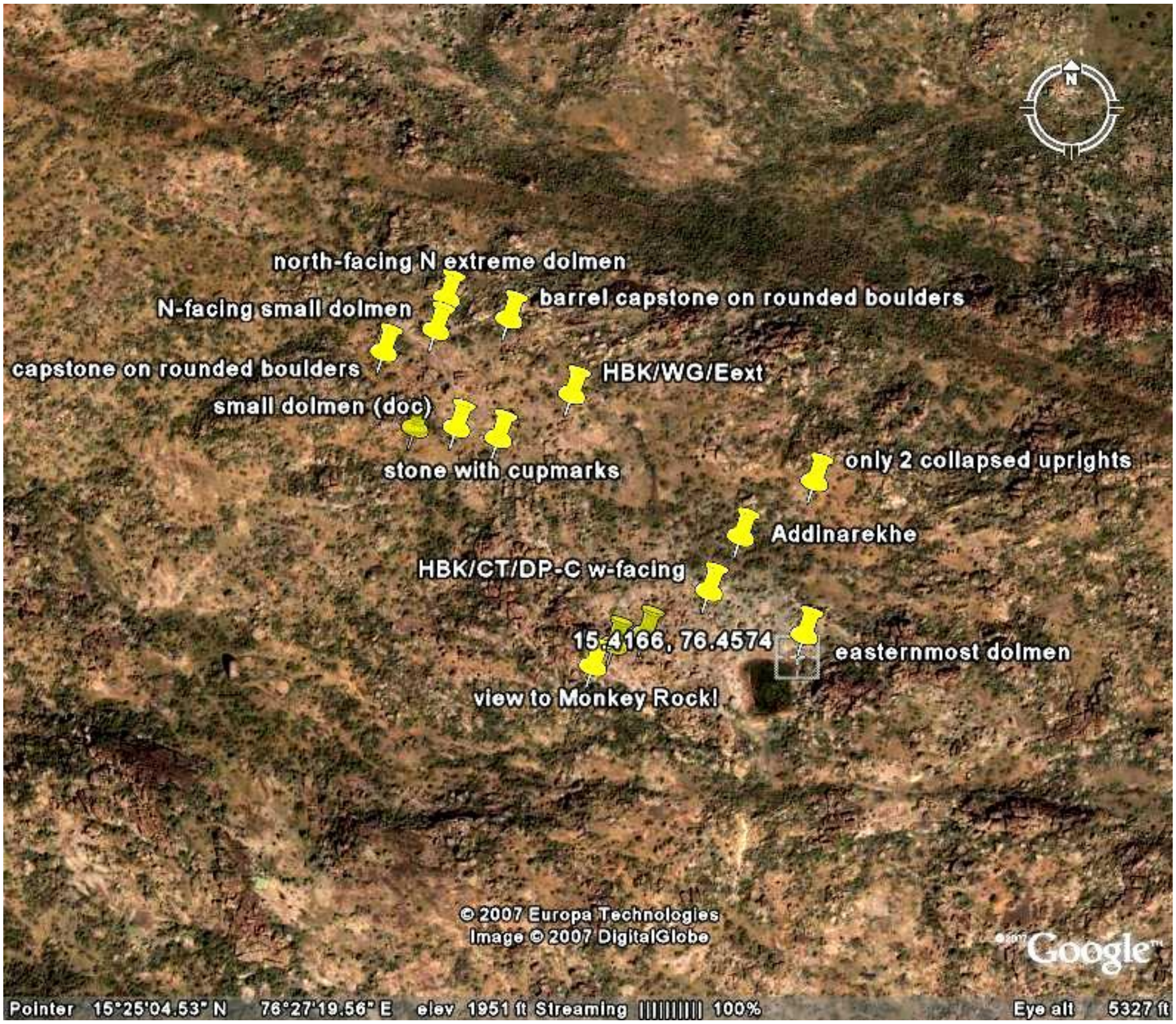


Figure 5.14: Showing the extent of the megaliths of the Western and Central groups at Hire Benakal; the Eastern group is off the lower right corner of the image

Orientations were not measured for rock shelter chambers (Fig. 1.7) due to the difficulty in determining a suitable axis for these. The orientation for IPC's is very approximate given the nature of construction of these (Fig. 5.15). The dolmenoid cists (Fig. 5.16) and the port-holed dolmens (Fig. 1.8) were the best constructions for which a definite axis could be determined. The direction of the orthostat slab containing the porthole was deemed to be the direction the dolmen or dolmenoid cist is facing, while for open dolmens the direction of the open end was deemed to be the direction the dolmen faced. The average height for a dolmenoid cist, from ground level to

bottom of capstone was 1m while the same for dolmens varied from 1.5m to 2m. The IPC's were all lesser than 0.8m high. All around the megaliths, the ground is strewn with rubble blocks and evidence of stone-working.

Table 5.2: Showing the summary of orientation data for randomly selected megaliths of Hire Benakal (Corrected for magnetic declination for Hire Benakal on date of survey = 1^o 29'W changing by 0^o 0'/year)

No.	Megalith	Lat-long	Orientation	Comments
1	Hbk/ct/ipc1	15 24.994 76 27.340	323.5^o	Could be "facing" the other way
2	Hbk/ct/ipc2	15 24.994 76 27.340	48.5^o	Close to ipc1
3	Hbk/ct/DP-1	15 25.001 76 27.355	239^o	Could be "facing" the other way; no porthole
4	Hbk/wg/DC-1	15 25.114 76 27.246	80.5^o	Portholed dolmenoid cist; in cluster
5	Hbk/wg/DC-2	Same	67.5^o	Portholed dolmenoid cist; in cluster
6	Hbk/wg/DC-3	Same	72.5^o	Portholed dolmenoid cist; in cluster
7	Hbk/wg/DC-4	Same	59.5^o	Portholed dolmenoid cist; in cluster
8	Hbk/wg/DC-N-ext	15 25.187 76 27.243	78^o	Could be "facing" the other way; no porthole
9	Hbk/wg/IPC-W-ext	15 25.154 76 27.209	54.5^o	Could be "facing" the other way
10	Hbk/wg/D-1	15 25.165 76 27.238	N-facing	Rough dolmen two slabs and capstone
11	Hbk/wg/IPC-1	15 25.174 76 27.280	68.5^o	
12	Hbk/wg/IPC-2	15 25.131 76 27.313	-	Too dilapidated for measurement
13	Hbk/ct/AF	15 25.055	13.5^o	Anthropomorphic figure; collapsed

		76 27.411		
14	Hbk/ct/D-1	15 25.081 76 27.455	-	Ruined dolmen? Only 2 orthostats
15	Hbk/ct/DP-2	15 25.023 76 27.391	288.5°	Portholed dolmen; in cluster
16	Hbk/ct/DP-3	Same	W-facing	Portholed dolmen; in cluster
17	Hbk/ct/DP-4	Same	W-facing	Portholed dolmen; in cluster
18	Hbk/ct/DP-5	Same	E-facing	Portholed dolmen; in cluster
19	Hbk/ct/DO-W-ext	15 25.0000 76 27.445	282.5°	Open dolmen

Figure 5.15: Showing a typical Irregular Polygonal Chamber at Hire Benakal

Figure 5.16: Showing a well-preserved dolmenoid cist at Hire Benakal

5.6 Onake Kindi: Onake Kindi is a rock art site near Anegondi, across the river Tungabhadra from Hampi – the famous Vijayanagara capital and south-east of Hire Benakal. Here, in a natural amphitheatre surrounded by low, boulder-strewn hills, several panels of rock art have been preserved and can still be seen. The amphitheatre can be entered from a narrow entrance in the north. At a rock shelter in the inner northern side is the largest and most elaborate panel (Fig. 5.17), which is referred to in Chapters 1 and 4. At 4 other places within the amphitheatre (in the southern arc) and 2 places on the outside to the east of the entrance are other panels of rock art – three instances of which are shown in Figs. 5.18-5.21.

Figure 5.17: Showing the most elaborate panel of rock art at Onake Kindi

Figure 5.18: Showing a rock shelter at Onake Kindi in the southern portion where Panel 4 is found

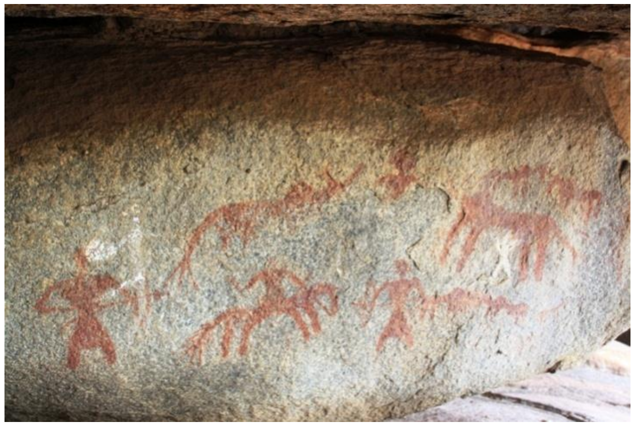


Figure 5.19: Another panel (4) of rock art in the south at Onake Kindi

Figure 5.20: A panel of rock art to the east of the entry to Onake Kindi

Panel 1 in the north, inside the amphitheatre shows everyday scenes on the vertical panel and the enigmatic depiction of a megalith (Figs. 1.11,3.14) on the horizontal overhang, as mentioned in Chapter 4. There is an ingenious depiction of a hooded serpent that stretches far into the recesses of the rock shelter and makes brilliant use of natural features of the ceiling of the cave, but this may be a later piece of art. Panel 2 in the south-east depicts a superhuman anthropomorphic figure on a high horizontal overhang with a small figure of a bull at its feet. Another shelter in the south has a lot of crude symbols that resemble script drawn on it (Panel 3). Panel 4 (Fig. 5.19) has depictions of mounted horsemen and spear bearers. Panel 5 has faded depictions of bulls etc. On the outside, east of the entrance are Panels 6 and 7 where depictions of human figures and deer etc. are dominated by large geometrical patterns (Fig. 5.20). There are many other motifs, embellishments and faded figures near many of the panels that are not mentioned here. This centre of rock art is most important in the study of megaliths because of the depiction of a stone circle megalith and possible expression of the meaning it held for the creators of these

monuments. The depictions of everyday life of the megalith builders are also important because they highlight the day-to-day activities of the cultures practicing this trait. Interestingly, one of the geometrical patterns depicted in the painting shown in Fig.5.20 is encountered etched on a rock at Gavali near the megalithic site of Kakkunje.

All surfaces have been prepared for painting by polishing. Majority of the paintings are in red ochre, but a few are in white kaolin (?) and have been interpreted as later art.

5.7 Nilaskal: The megalithic site at Nilaskal is situated about 7km from Nagara by road and is nearly 66km due south of Byse as the crow flies. This is an extensive and impressive site with the remnants of nearly a hundred menhirs (as evident from this study), some of them still standing, spread out over an area of approximately 100m E-W x 300m N-S. A road running from north to south divides the site into two unequal halves and some of the menhirs have obviously been destroyed by a school building in the northern part of the site and residences in the eastern side of the road. Some of the menhirs are inside a plantation adjacent to the school in the northern portion of the site, but most of the prominent menhirs are in a clearing in the western portion that constitutes the largest part of the site. Fig.5.21 shows the satellite image of the site and surroundings.

Figure 5.21: Showing the megalithic site at Nilaskal

The largest menhirs at the site are roughly 3m wide at the base and 6m high, but only 30cm thick. One of these is adjacent to the road (Fig. 1.10) and the other is in private residential property in the eastern portion (Fig. 5.22). The terrain slopes gently upwards to the west and thus forms an artificial horizon towards the west (Fig. 6.11). To the east, the horizon is unobstructed except for trees and other vegetation that, presumably, are recent. During the surveys undertaken for this study, we have found the remnants of nearly a hundred stones at Nilaskal. There is severe disturbance in several parts of the site – in the north, where a school has been built; in the south where earth has been excavated in a large area; in the north-east and east where a residence has been built etc. Among the stones still standing, we have estimated that 25 of the stones are in the position that they have been originally erected in. This is due to their large size and the manner in which they are still embedded in the ground. Both of the largest menhirs surviving on the site, shown in Fig. 1.10 and Fig.5. 22, fall into this category. The remaining stones are fragments and smaller stumps and have been broken by residents to serve as readily available building construction material, as in the case of the example shown in Fig.5. 23.

Figure 5.22: The second-largest surviving menhir at Nilaskal

Figure 5.23: Showing the broken stump of a menhir at Nilaskal

We visited the site a total of 9 times since 2007 and studied the site and surroundings (Menon, Vahia and Rao 2012a) and also prepared a topographic map using a total station in view of the gentle slope up towards the west of the site in general. The site map with contours is given as Map 1. A summary of the orientation of the long axes for some of the large stones at Nilaskal for which reliable orientation data could be obtained is given in Table 5.3.

Table 5.3: Summary of the orientation data for the largest menhirs of Nilaskal (Corrected for magnetic declination for Nilaskal on date of survey = 1^{o} 41'W changing by 0^{o} 0'/year)

Stone No.	Lat-Long	Orientation	Comments
74	13 46.591 75 01.145	358.5^{o}	Biggest of all, leaning, roughly rectangular, 297cm wide at base.
48, 49	13 46.574 75 01.146	345.5^{o}	Broken pieces, roundish.
43	13 46.564 76 01.145	14.5^{o}	Broken stump, rectangular, accorded main stone status only because it seems to be the southernmost in this row.
40	13 46.561 75 01.142	0.5^{o}	Broken, notch on upper face?
73	13 46.596	?	

	75 01.144		
72	13 46.600 75 01.143	343^{o}	Close to 5.
71	13 46.602 75 01.141	16^{o}	Near tree, highly disturbed, recently broken by lorry.
70	13 46.609 75 01.140	327.5^{o}	Broken, highly disturbed, near road edge.
83	13 46.652 75 01.110	321^{o}	Close to school.
85	13 46.678 75 01.095	326^{o}	In school.
82	13 46.650 75 01.100	343.5^{o}	Sparse tree cover, in grove.
81	13 46. 630 75 01.095	328.5^{o}	Chisel marks on the east face, in grove.
77	13 46.622 75 01.107	30.5^{o}	In grove.
75	13 46.615 75 01.107	336^{o}	In S edge of grove, near ground, split into two vertically.
11	13 46.619 75 01.122	358.5^{o}	
69	13 46.605 75 01.134	14.5^{o}	Disturbed? Close to scooped area near road, near scooped edge.
68	13 46.597 75 01.133	356^{o}	Under tree, notch at top?
57	13 46.584 75 01.133	355	
32	13 46.581 75 01.129	356	
28, 29	13 46.592 75 01.120	356	In two pieces.
18	13 46.596 75 01.122	4.5^{o}	Sharp-tipped stone, prominent
25	13 46.593 75 01.113	7.5^{o}	
16	13 46.602 75 01.126	341^{o}	Near plant, fragments scattered east of this stone.

5.8 Byse: A few kilometres from the historic town of Nagara on the road to Kollur is the village of Byse. Here, *Nilaskal Byana* – lit. "The field with the standing stones" is a small, flat clearing about 200m E-W x 600m N-S. The site was first reported by Sundara (1969) as containing several menhirs arranged in no particular pattern. These sites are not excavated systematically,

but a hurried excavation of few cists near the site at Byse yielded pottery (dull red ware and black ware) and human bones but no iron objects (Sundara 2004).

We have visited the site seven times since 2007 and have surveyed the site and studied the surroundings (Menon and Vahia 2010, Menon and Vahia 2011, Menon, Vahia and Rao 2010, Menon, Vahia and Rao 2012a, Menon, Vahia and Rao 2012b). We have recorded the positions and orientations of all the standing stones and positions of the fallen ones, as well as other site features such as mounds and cairns. The survey used a prismatic compass, a laser distometer and a hand-held Garmin GPS. The megalithic site at Byse consists of 26 menhirs – 13 of which are still standing, the rest being broken stumps or pieces. Many others may be missing. The largest menhir is 3.6m tall, 1.6m wide and 25cm thick (Fig.5.24) and is worshipped as *Bhootaraya* under the prevailing local custom of ancestor worship. The menhirs are scattered in two clusters in an area roughly 60m (E-W) x 65m (N-S), in the northern portion of the clearing, though 20 of the 23 menhirs are in an area 30m (E-W) x 60m (N-S). The stones are mostly large undressed boulders of elongated cross section of granite (Fig.5.25). There are a few quarried slabs too (Fig.5.26).

Figure 5.24: The largest menhir at Byse

Figure 5.25: One of the prominent menhirs at Byse - an undressed boulder

Figure 5.26: A quarried slab that acts as a menhir at Byse

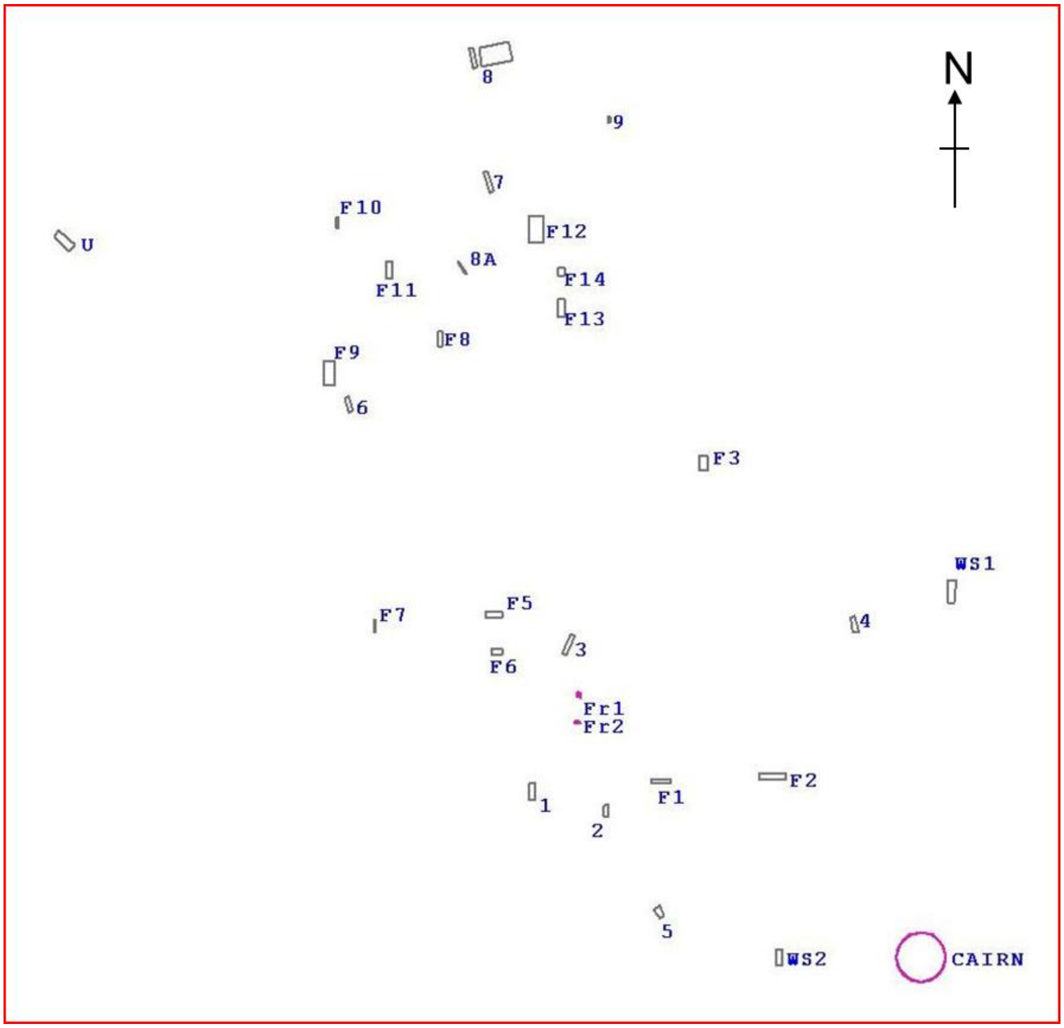


Figure 5.27: The layout of the menhirs at Byse

A layout map of the menhirs at Byse is shown in Fig.5.27. The orientation data for stones for which the same could be measured is given in Table 5.4. Orientation data were not taken for fallen stones.

Table 5.4: Summary of the orientation and size data for the largest menhirs of Byse (Corrected for magnetic declination for Byse on date of survey = 1^{o} 40'W changing by 0^{o} 0'/year)

Stone no.	L (m)	B (m)	H (m)	Az.
B1	1	0.45	1.7	178.5^{o}
B2	0.8	0.3	0.7	178.5^{o}
B3	1.45	0.3	1.26	204.5^{o}
B4	1.03	0.32	1	170.5^{o}
B5	0.7	0.38	1	152.5^{o}

B6	0.98	0.27	0.89	158.5^o
B7	1.37	0.27	0.77	165.5^o
B8	1.3	0.23	0.58	168.5^o
B8-A	0.96	0.12	1.15	147^o
B9	0.45	0.23	0.76	no measure
B-WS-1	1.5	0.45	3.6	181^o
B-WS-2	1.06	0.38	1.06	183^o
B-U	1.4	0.56	1	131.5^o

5.9 Heragal: The megalithic site at Heragal (Fig. 5.28) seems to consist almost wholly of undressed boulders of elongated shape and lenticular cross-section (Fig. 5.29). There is evidence for a lot of disturbances at the site. Two menhirs each are under worship by the local communities, though there are no shrines enclosing either of these (Fig. 5.30). Of course, this worship is very likely a recent phenomenon on archaeological timescales, with most probably no cultural continuity with the tradition that erected the menhirs. The site has menhirs or stumps of menhirs scattered over an extensive area and this site deserves to be thoroughly surveyed and investigated.

Though constraints of time and resources prevented a thorough survey of the site during this study, it was noticed that most of the menhirs at Heragal seemed to have their long axes of cross-section oriented north-south (Fig. 5.31). In form and character, the site seems to follow the Byse typology, with a large number of undressed boulders rather than dressed or quarried slabs, as well as from the point of view of individual menhir orientations.

Figure 5.28: A general view of the megalithic site at Heragal

Figure 5.29: Showing typical menhir cross-section at Heragal

Figure 5.30: One of the tallest menhirs under worship at Heragal

Figure 5.31: Showing a typical menhir orientation at Heragal

5.10 Mumbaru: The megalithic site at Mumbaru also appears to consist wholly of undressed natural boulders of similar cross-section to Heragal and Byse. Here too, there was evidence for a lot of disturbances – with several broken and collapsed menhirs (Fig.5.32). Two menhirs each were under worship by the local communities at Mumbaru also, with the two worshipped menhirs having small shrines around them. The largest menhir is in a formal shrine with poojas (Fig. 5.33), but a smaller stone near the road cutting through the site, has a small, open shrine and is known as *Dibbannada Kallu* locally and is of significance in marriage ceremonies. Mumbaru too has menhirs and stumps scattered over a large area and a thorough survey is called for. The individual menhirs at Mumbaru also exhibit similar characteristics (Fig.5. 34) and orientation patterns to Byse.

Figure 5.32: A general view of the site at Mumbaru

Figure 5.33: The largest standing menhir under worship in a shrine at Mumbaru

Figure 5.34: Showing typical menhir cross-section at Mumbaru

5.11 Eyyal: Eyyal near Thrissur is a rock-cut burial with two chambers (Fig. 4.15) excavated in laterite rock. There is a rock bench of irregular width running on three sides of the main chamber. The carving is very utilitarian and there are no embellishments of any kind. Orientation data for the chambers is given in Table 5.5, along with the other sites near Thrissur.

5.12 Kudakkallu Parambu: The site at Cheramanangad near Thrissur is a burial site with megaliths (Fig.112). Several kudakkals, topikals and multiple hood stones etc. are seen at the site. The orientations of the vertical joints of clinostats of all intact kudakkals have been measured and are presented in Table 5.5.

5.13 Chowwannur: The megalith at Chowwannur is also a rock-cut burial cave (Fig. 5.36). It is single-chambered and the entry is from east via a recessed opening from a rectangular sunken court accessed by steps. The plan-form of the chamber is apsidal and the ceiling hemispherical. There are embellishments on the entry portal and two benches along the floor on either side of the entry. Circular rings have been carved at the rear (western end) of the cave for holding burial jars. The orientation of the cave is given in Table 5.5.

5.14 Kakkad: This, too, is a rock-cut burial cave excavated in laterite. Entry is again from the east, via a sunken court and a narrow entrance portal. The cave is parabolic in plan and has a dome shaped ceiling with a circular opening to the top. There is a single well-carved bench along the northern side and a vessel stand. There are fine laterite ribs carved on either side of the entry inside the cave (Fig. 5.37).

Figure 5.35The megaliths at Kudakkallu Parambu

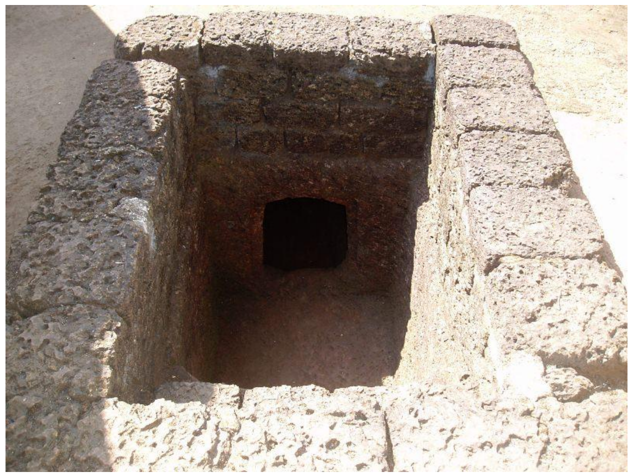


Figure 5.36: The rock-cut burial cave at Chowwannur

5.15 Kattankampal: This is a four-chambered rock-cut burial cave (Fig. 5.38). The entry is via a sunken court with steps in the east and two chambers in the west, with one each in the north and south. There is a bench in each chamber and the whole arrangement is symmetrically laid out. The orientations of each chamber are given in Table 5.5.

Figure 5.37: An interior view of the rock-cut burial cave at Kakkad, looking towards the entry

Figure 5.38: A view of the four-chambered rock-cut burial cave at Kattankampal

5.16 Ariyannoor: This is a site with several Kudakkals, known locally as the "Ariyannoor Umbrellas" (Kudakkal literally means "Umbrella Stone" in Malayalam). There are five intact kudakkals and a couple of collapsed ones. They are shorter in height than the kudakkals at Kudakkallu Parambu. The orientations of the vertical joints of clinostats of all intact kudakkals have been measured and are presented in Table 5.5.

5.17 Kandanasserry: This rock-cut burial cave is single-chambered and is entered via a recessed opening. It, too, has a parabolic floor plan and a hemispherical ceiling with a circular opening to the top. There are three benches on the sides of the cave. The orientation of the cave is given in Table 5.5.

Figure 5.39: A view of the Ariyannoor Umbrellas

Figure 5.40: A view of the rock-cut burial cave at Kandanasserry

Table 5.5: Summary of the orientation and other data for the megalithic monuments of Thrissur (Corrected for magnetic declination for Byse on date of survey = 2^{o} 12'W changing by 0^{o} 0'/year)

Megalith	Lat-Long	Az.	Comments
RC-Eyyal	10.65761 76.11925	95, 181	Main chamber, side chamber (in that order)
Kudakkal 1	10.68534 76.12176	191	Cheramanangad, complete kudakkal 1
Kudakkal 2	10.68575 76.12164	188	Cheramanangad, 2nd complete kudakkal, near road (fence); under tree
Kudakkal 3	10.68611 76.12101	164	Cheramanangad, 3rd complete kudakkal; height from ground to bottom of capstone 1.387m; overhang 1.268m
???		179	Semi-circular feature near complete kudakkal 1; orientation of line between tallest stones.
RC-Chowwannur	10.65597 76.08248	90	Single chamber; 2 benches
RC-Kakkad	10.66161 76.06858	93	Entry and circular skylight; elegantly sculpted benches
RC-Kattankampal	10.68703 76.03917	82, 165, 345.5	4 chambered; facing 2 chambers and the 2 side chambers
AKudakkal1	10.60571 76.08528	56, 321	Ariyannoor, Height 0.734
AKudakkal2	Only one reading	108, 13	Ariyannoor, Height 0.811
AKudakkal3		137, 28	Ariyannoor, Height 0.926
AKudakkal4		53, 328	Ariyannoor, Height 0.673
AKudakkal5		118, 18	Ariyannoor, Height 0.681

RC-Kandanassery	10.59953 76.08259	298	Entry plus circular skylight…

5.18 Aihole: The megaliths of Aihole are located atop the Meguti Hill, distributed between the Jaina Temple of Ravikirti's inscription in the north-west and the rock-cut Jaina cave in the south-east. The megaliths, hewn out of the local sandstone appear very crudely finished, but the effects of weathering too contribute to the condition. The megaliths consist of Irregular Polygonal Chambers (Fig. 5.41), like those at Hire Benakal, consisting of slabs raised on 3-4 small boulders and whose rubble packing has mostly disappeared; as well as dolmens with (Fig. 5.42) or without (Fig. 5.43) portholes. The orthostats of the dolmens do not interlock to prevent inward collapse as in those at Hire Benakal, suggesting that these are older. Many slabs have collapsed inwards as a result. Portholes are seen in U-shaped, semi-circular and even square forms, the latter two being located on the edges of their orthostats.

Figure 5.41: An IPC at Meguti Hill, Aihole (Meguti Temple in the background)

Figure 5.42: A dolmen with a U-shaped porthole and a passage

Figure 5.43: A dolmen without porthole at Aihole

There is a tank in the north end of the hill, which seems to have resulted as a consequence of the quarrying activities, similar to the tank at Hire Benakal. Here Sundara (1975) reports an anthropomorphic figure, but it could not be traced during this study.

The orientation of the dolmens in a reasonably good condition was measured. The orientations of the IPC's were not measured since almost all of them were sans their rubble packing and thus the positions of any openings that may have existed cannot be ascertained. The orientation data for the Meguti Hill megaliths are given below in Table 5.6. The megaliths in which portholes are not present can be deemed to face the other way, too.

Table 5.6: Summary of the orientation and other data for the megalithic monuments at Meguti Hill, Aihole (Corrected for magnetic declination for Aihole on date of survey = 1^o 20'W changing by 0^o 0'/year)

Megalith	Lat-Long	Orientation	Comments
Dolmen 1	16.01571 75.88425	-	Collapsed
Dolmen 2	16.01622 75.88461	116^o	
Dolmen 3	16.01607 75.88474	-	Collapsed; slab circle around
Dolmen 4	16.01597 75.88481	-	Collapsed
Dolmen 5	16.01582 75.88505	53^o	Porthole and passage
Dolmen 6	16.01615 75.88535	345.5^o	Intact; only one inwardly collapsed orthostat
Dolmen 7	16.01523 75.88657	75.5^o	Intact; square porthole to one side of orthostat
Dolmen 8	16. 01522 75.88651	137.5^o	Intact; one side open
Dolmen 9	16.01506 75.88662	-	Collapsed; another ruined dolmen adjacent
Dolmen 10	16.01495 75.88691	6.6^o	Intact; one side open
Dolmen 11	16.01448 75.88712	64.5^o	Intact; one side open
Dolmen 12	16.01446 75.88719	88.5^o	
Dolmen 13	16.01441 75.88746	East facing	Double wall intact
Dolmen 14	16.01443 75.88749	East facing	
Dolmen 15	16.01445 75.88755	-	All sides closed
Dolmen 16	16.01428 75.88758	200.5^o	Open side facing away from valley
Dolmen 17	16.01402 75.88795	358.5^o	Open side facing away from valley
Dolmen 18	16.01387 75.88799	-	Collapsed; looking down?
Dolmen 19	16.01377	-	Collapsed

	75.88804		
Dolmen 20	16.01361 75.88802	-	Collapsed; looking down?
Dolmen 21	16.01348 75.88794	-	Collapsed; near way to Jaina Cave
Dolmen 22	16.01373 75.88678	93.5^{o}	With porthole
Dolmen 23	16.01377 75.88676	73.5^{o}	With porthole
Dolmen 24	16.01380 75.88673	164.5^{o}	With porthole
Dolmen 25	16.01466 75.88667	-	Collapsed
Dolmen 26	16.01478 75.88667	-	Collapsed; with termite hill
Dolmen 27	16.01507 75.88609	319.5^{o}	Open; near a big mound

Apart from the dolmens and IPC's there were other features like a big mound, a rectangular platform-like structure and some other such structures that were not studied.

Figure 5.44: The port-holed chamber tomb at Bachinagudda

5.19 Bachinagudda: Bachinagudda, close to Pattadakal, has two megalithic monuments. One is a passage grave covered by four slabs instead of the customary single capstone, made of local sandstone. The orientation of this is 174.5^{o} (south-facing). The other megalith is a port-holed chamber tomb (Fig. 5.44) executed in granite-gneiss with a square porthole and its orientation is 164.5^{o}, also south facing.

5.20 Hanamsagar: Hanamsagar is a very important stone alignment/avenue site. It is the largest alignment in Karnataka (and possibly India), comprising of more than 2500 boulders arranged in some pattern. The alignment site at Hanamsagar (16° 19' 31"N, 76° 27'05"E) is a plain surrounded by low rocky hills except towards the approach to the site from the south. This site could not be completely surveyed during this study due to paucity of time and resources, especially given the large extent and remoteness of the site. However, the site was photographed from a hill in the south-west (Fig. 5.45) and alignment data collected at a few random points (Fig. 5.46) within the arrangement of stones.

The local legend ascribes the regular arrangement of stones to an invading army that came marching over the hills to steal a golden cradle that was suspended between two pillars of rock visible on the horizon (Fig.5.47) and got turned into stone as soon as the leader touched the cradle. The bearing of this point on the local horizon was also measured.

Figure 5.45: A view of the alignment at Hanamsagar from a hill in the south-west

The alignment data collected within the monument is summarised in Table 5.7. The alignments were measured to a "best-fit line" for a given line of stones visible from each station point.

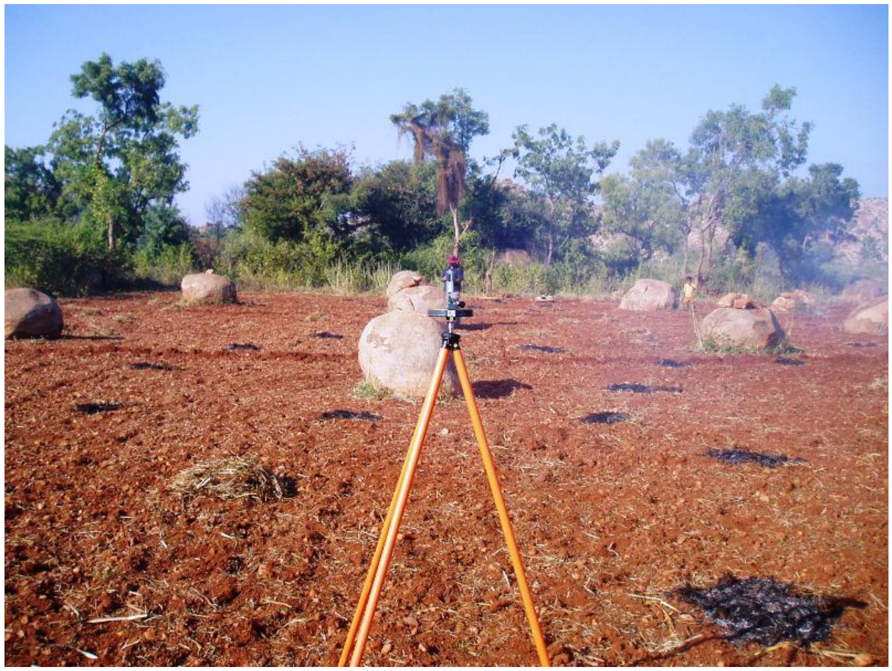


Figure 5.46: Showing collection of alignment data at a point within the arrangement of stones

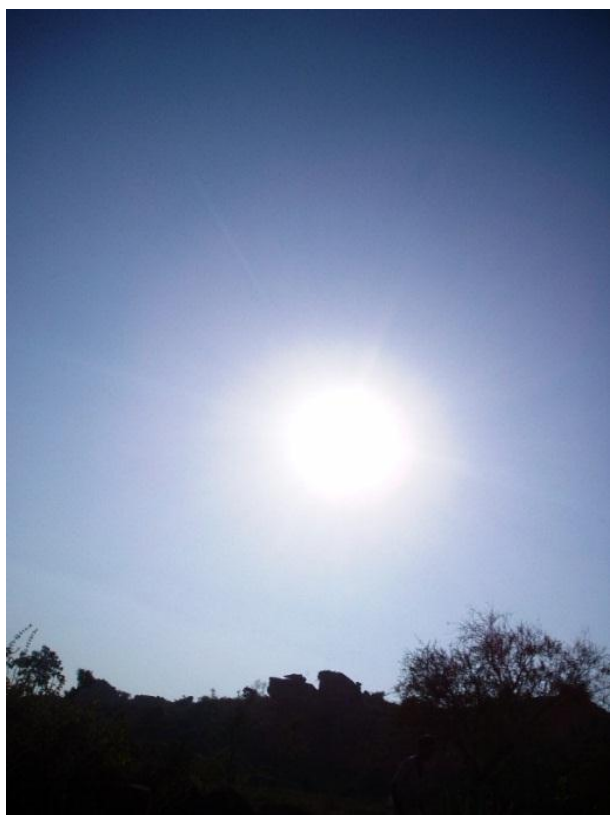


Figure 5.47: The winter sun descends towards the rock pillars which held the golden cradle of local legend at Hanamsagar

Table 5.7: Summary of the alignment data for the megalithic monument at Hanamsagar (Corrected for magnetic declination for Hanamsagar on date of survey = 1^o 18'W changing by 0^o 0'/year)

Point	Lat-long	Direction	Bearings	Comments
1	16.32433 76.44916	N S E Diagonal	357.5 179.5 97 137	8 stones along line visible
2		N S E	1 190 97	Continuing the line from point 1
3	16.32349 76.45129	E	97.5	6 stones along line visible
4	16.32536 76.45124	N	1.5	
5	16.32501 76.45193	S W	184.5 276.5	
6	16.32483 76.45140	Towards "cradle"	244	A line of stones pointing towards the rock pillars which held the legendary "golden cradle"
7	16.31861 76.45573	N	358	

5.21 Kyaddigeri: Our visit in January 2008 revealed not a single megalith in this field to the east of Meguti Hill across a valley where, Sundara (1975) had observed more than 60 megaliths including passage graves and a double boulder circle. Several signs of recent excavations (Fig. 5.48) at targeted areas within the field indicated that the damage was recently perpetrated and targeted specifically at removing the megaliths. Signs of fresh quarrying close to the Jaina cave (Fig. 5.49), which is a protected monument, points to undesirable destructive activities blatantly carried out and calls out for a proper enforcement of the protection afforded to our monuments.

Figure 5.48: Evidence for a recent removal of a megalith at Kyaddigeri (Meguti hill and temple in background)

Figure 5.49: Signs of fresh quarrying very close to the Jaina Cave on Meguti Hill

5.22 Chik Benakal: The megalithic site of Chik Benakal is about 3km to the west of the extensive site at Hire Benakal, across a ridge of a granite hill. It appears to be a severely disturbed site (Fig. 1.6) with remnants of at least 15 dolmenoid cists (Fig.5.50) of the Hire Benakal type. There seems to be remnants of a few rock-shelter chambers, too (Fig.5.51). The site showed fresh signs of looting (Fig. 5.52) by treasure seekers during a visit in January 2008.

Orientations were measured for those dolmenoid cists whose orthostats seemed to be more or less intact. A couple of the megaliths had portholes close to the ground similar to those of Hire Benakal, but the other ones with the front orthostat missing could also have had portholes. Chik Benakal seems to have been a smaller site of the same culture that erected and used Hire

Benakal. The orientation data for the dolmenoid cists at Chik Benakal are summed up in Table 5.8.

Figure 5.50: One of the dolmenoid cists at Chik Benakal

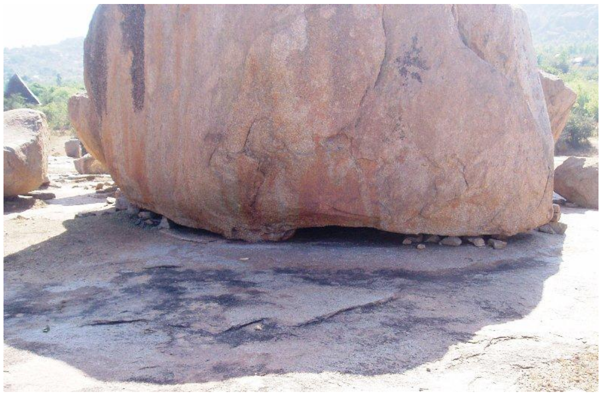


Figure 5.51: A possible rock-shelter chamber at Chik Benakal

Figure 5.52: A freshly looted megalith at Chik Benakal in January 2008

Table 5.8: Summary of the orientation and other data for the dolmenoid cists at Chik Benakal (Corrected for magnetic declination for Chik Benakal on date of survey = 1^{o} 26'W changing by 0^{o} 0'/year)

Dolmen	Lat-Long	Orientation	Comments
1	15.40684 76.43047	-	Only 1 broken upright (rear one?)
2	15.40704 76.43047	-	Only 1 broken upright
3	15.40707 76.43041	-	Mound of rubble – masonry blocks
4	15.40713 76.43032	-	1 broken upright; anthill; rubble mound
5	15.40705 76.43012	84^{o}	2 uprights plus one
6	15.40703 76.43015	52^{o}	3 uprights
7	15.40702 76.43019	88^{o}	3 uprights
8	15.40700 76.43025	77^{o}	2 uprights
9	15.40701 76.43031	65^{o}	Only 1 upright
10	15.40693 76.43024	55^{o}	1 stump plus 2 orthostats; passage?
11	15.40697 76.43011	-	Ransacked! GPS point midway between 11 and 12
12	Same	38^{o}	Near cactus, with porthole partly sunk in ground.
13	15.40704 76.43007	65^{o}	Cactus inside; 2 uprights?
14	15.40680 76.43011	-	2 uprights plus lots broken
15	15.40675 76.43013	-	Anthill inside

5.23 Vibhutihalli: The stone alignment/avenue at Vibhutihalli is the best preserved megalith of this typology in Karnataka. The site was visited in December 2008, when certain lines in the alignment were noticed to point towards the setting (Fig. 5.53) and rising (Fig. 5.54) sun. A small portion of the alignment in the nursery in the south-east was surveyed, when it was found that the lines between adjacent stones were misleading, because the stones in any particular row

are laid out about the "best-fit line" and thus a complete survey is called for, just as at Hanamsagar. A total station was carried out by the Archaeological Survey of India (ASI) and the map obtained from that survey is given in Fig. 5.55.

Figure 5.53: A part of the alignment at Vibhutihalli pointing to the sunset on 31 December 2008

Figure 5.54: A part of the alignment at Vibhutihalli pointing to the rising sun on 01 January 2009

Figure 5.55: The survey map of the stones of Vibhutihalli; north is towards top

5.24 Bheemarayanagudi: The site of B'gudi, as it is known locally, is 5km to the west of Vibhutihalli. The site, or what remains of it, is to the south of the Shahpur-Sindegi road, in the premises of what now is the office of the Forest Department. There are 6-7 large, undressed boulders, much larger than that of Vibhutihalli, and one fallen menhir that seems dressed (Fig. 5.56) distributed at various locations in the compound. It is possible that they were arranged in a grid too (Fig. 5.57), but it is difficult to ascertain with the scanty remains today.

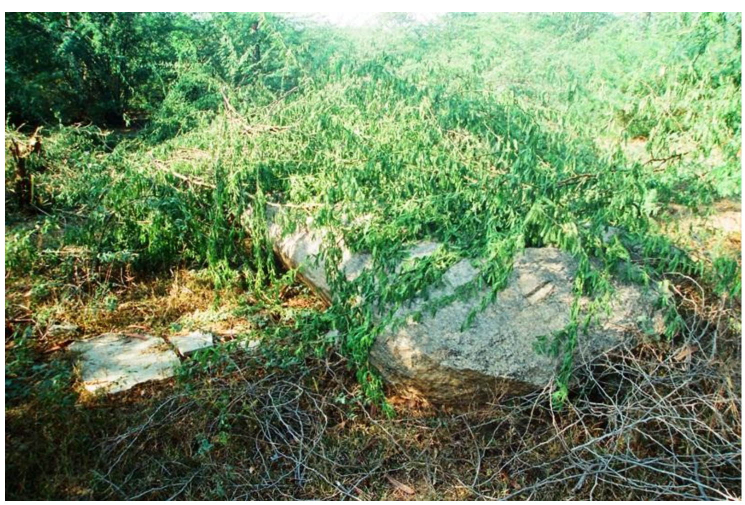


Figure 5.56: The fallen dressed menhir at B'gudi

Figure 5.57: Four of the boulders at B'gudi

Bearings were taken for the intersecting lines made by four boulders shown in Fig. 5.57, and they were 276.5^{o} and 354^{o} which is consistent with a grid oriented to the cardinal points but 4 points do not really help establish that. The 3 other rocks that were found were too far away from these four to make any conclusions.

5.25 Gudde Maradi: Gudde Maradi is located south of Shimoga town and is reported (Sundara 1975) to contain at least 5 menhirs of quarried stone. Our visit in December 2008 revealed that all the menhirs were destroyed without a trace, perhaps due to the activities of a granite crushing unit functioning near the site (Fig. 5.58).

Figure 5.58: A granite crushing unit near the site of Gudde Maradi

5.26 Konaje Kallu: The megalithic site near the unique natural rock formation of Konaje Kallu is to the east of the twin summits of Konaje Kallu. There are two intact port-holed dolmens and

the collapsed remains of at least three more and rubble, quarried slabs etc. lying on the flanks and summit of a rocky hill. Both dolmens are of the same type as the large dolmens of the central group at Hire Benakal with circular portholes in the centres of their eastern orthostats. The dolmen at the summit has two small slabs marking a passage in front of the porthole, too (Fig.5. 59). The porthole of the dolmen on the summit is polished too (Fig.5. 60) – a feature that is not encountered at any other megalithic site studied in this investigation. There is a large slab, slightly less than half the height of the orthostats, on end inside the intact dolmen on the summit, indicating that maybe the dolmen was transepted inside. Both the intact dolmens are east facing.

Figure 5.59: The intact lower dolmen at Konaje Kallu

Figure 5.60: The passage and polished porthole of the dolmen on the summit at Konaje Kallu

5.27 Kakkunje: The megalithic site at Kakkunje consists of one almost intact dolmen and at least one more collapsed dolmen amidst scrub jungle. The intact dolmen (Fig. 5.61) has three orthostats and the capstone still intact, with the orthostat in the north (a side orthostat) having fallen outwards. The porthole is in the western orthostat – quite low down, almost near the ground. Both at Konaje Kallu and Kakkunje, the dolmens resemble those of the central group at Hire Benakal, but the placement of the porthole and the presence of a passage in one of the Konaje Kallu dolmens resemble the dolmenoid cists of the western group at Hire Benakal. A most interesting feature of the Kakkunje dolmen is that the eastern orthostat seems to be a slab off the upper surface of a rock-bed with an intrinsic curvature; with the builders of the dolmen trying to match it by tooling the western slab containing the porthole to the same curvature (Fig. 5.62). There are also signs of quarrying in rock patches nearby (Fig.5. 63). The orientation of the dolmen is 261^{o}.

Figure 5.61: The dolmen at Kakkunje

Figure 5.62: Detail of the western orthostat of the dolmen showing attempts to shape the slab to match the curvature of the eastern orthostat

Figure 5.63: Signs of quarrying nearby at Kakkunje

The collapsed dolmen nearby also has a porthole in the western orthostat.

5.28 Rajan Koluru: The megalithic site at Rajan Koluru is very close to Hanamsagar. Contrary to reports (Meadows-Taylor 1853, Sundara 1975), only 47 intact dolmens were found at the site, distributed in two non-uniform groups, separated by a patch of agricultural land. It is quite possible that some of the megaliths were destroyed to free up space for more agricultural land. There are 43 intact dolmens in the western group (Fig. 5.64) and 4 intact ones in the eastern group. All megaliths are south facing, the orientations are summarised in Table 5.9. Several ruined dolmens are not noted below.

Figure 5.64: A panoramic view of the western group at Rajan Koluru

Many of the dolmens of the western group have crude portholes made in the southern orthostat (Fig. 5.65). Another feature of this site is the shaping of the side orthostats (Fig.5. 66). Stylistically, these dolmens resemble the ones at Meguti Hill rather than the ones at Hire Benakal, Chik Benakal, Konaje Kallu, and Kakkunje. The orthostats of both Aihole and Rajan Koluru do not interlock to prevent inward collapse in the manner of the other sites mentioned. In the eastern group, however, one of the four intact dolmens had a circular porthole close to the ground in the manner of the dolmenoid cists of Hire Benakal.

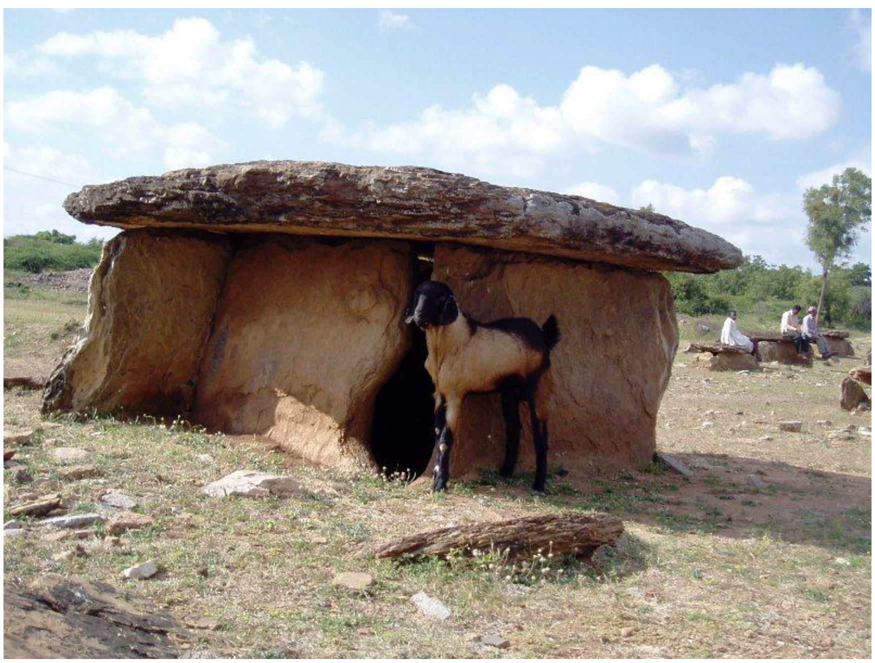


Figure 5.65: A dolmen of the western group at Rajan Koluru showing a crudely fashioned porthole in the southern slab

Figure 5.66: A dolmen of the western group at Rajan Koluru showing shaping of side orthostats

Figure 5.67: Showing a port-holed dolmen of the eastern group at Rajan Koluru

Table 5.9: Summary of the orientation and other data for the dolmens at Rajan Koluru (Corrected for magnetic declination for Rajan Koluru on date of survey = 1^{o} 9’W changing by 0^{o} 1’/year)

Dolmen	Lat-long	Orientation	Comments
1	16 22 34.6 76 27 03.0	181^{o}	N-W-most
2	Same	178^{o}	
3	16 22 34.9 76 27 03.1	181^{o}	Anthill inside
4	16 22 34.5 76 27 03.1	186^{o}	

5	16 22 34.4 76 27 03.2	193^{o}	
6	16 22 34.3 76 27 03.3	193^{o}	
7	16 22 34.1 76 27 03.2	194^{o}	
8	16 22 34.0 76 27 03.3	192^{o}	Low dolmen
9	16 22 34.1 76 27 02.9	178^{o}	Westernmost
10	16 22 33.9 76 27 03.0	179^{o}	Depression to its east – quarry?
11	16 22 33.4 76 27 03.6	174^{o}	Southernmost of the central group
12	16 22 33.6 76 27 03.7	178^{o}	
13	16 22 33.7 76 27 03.7	188^{o}	
14	Same?	-	Too ill-defined to measure; low
15	16 22 35.1 76 27 03.3	189^{o}	
16	16 22 34.9 76 27 03.4	176^{o}	
17	16 22 35.1 76 27 03.7	188^{o}	Northernmost of the central group
18	16 22 35.0 76 27 03.9	178^{o}	
19	16 22 34.9 76 27 03.9	180^{o}	
20	16 22 35.5	186^{o}	

	76 27 04.2		
21	16 22 35.8 76 27 04.4	197 ^{o}	Large
22	16 22 36.0 76 27 04.6	176 ^{o}	Largest? Height to bottom of capstone 1.6m
23	16 22 35.8 76 27 05.2	184 ^{o}	Rubble and anthill in south
24	16 22 35.9 76 27 05.6	189 ^{o}	Dilapidated, on ASI-built rubble wall
25	16 22 35.6 76 27 04.0	183 ^{o}	
26	16 22 35.5 76 27 05.0	188 ^{o}	
27	16 22 34.9 76 27 04.5	194 ^{o}	Next to a tree
28	16 22 35.0 76 27 04.1	185.5 ^{o}	
29	16 22 34.6 76 27 04.0	196 ^{o}	Small; disturbed
30	16 22 34.6 76 27 04.1	183 ^{o}	Small
31	16 22 34.2 76 27 04.6	189 ^{o}	Large
32	16 22 33.9 76 27 05.2	179 ^{o}	Largest on site; ASI-built rubble wall
33	16 22 33.4 76 27 05.0	171 ^{o}	
34	16 22 33.7 76 27 04.7	180 ^{o}	Tallest on site
35	16 22 33.3	182 ^{o}	Well-shaped orthostats

	76 27 04.8		
36	16 22 33.1 76 27 04.8	176 ^{o}	
37	16 22 33.1 76 27 04.3	176 ^{o}	Southernmost intact dolmen
38	16 22 32.8 76 27 04.6	-	Southernmost remnants
39	16 22 33.3 76 27 04.3	181 ^{o}	
40	16 22 33.5 76 27 04.5	186 ^{o}	
41	16 22 33.6 76 27 04.4	183 ^{o}	
42	16 22 33.6 76 27 04.2	186 ^{o}	
43	16 22 33.7 76 27 04.2	179 ^{o}	Near tree
44	16 22 36.9 76 27 15.3	192 ^{o}	Eastern group
45	16 22 37.5 76 27 14.9	169 ^{o}	Eastern group; port-hole (circular) present
46	16 22 37.3 76 27 14.5	168 ^{o}	Eastern group
47	16 22 37.0 76 27 13.9	174 ^{o}	Eastern group

5.29 Aaraga Gate: The site at Aaraga Gate was discovered during the course of explorations for this investigation. One large erect menhir and the stumps of seven other menhirs were found in a plantation close to the town of Aaraga. The largest menhir on site (Fig. 5.68) is a roughly hewn block of rectangular cross section. All the rest seem to be natural boulders of elongated cross

section. Seven of the eight menhirs were found to have their long-axes of cross section oriented north-south (Fig. 5.69), as at Nilaskal, Byse, Heragal and Mumbaru – confirming Aaraga Gate as yet another site of that typology. A full survey is yet to be carried out at the site at Aaraga Gate.

Figure 5.68: The largest menhir at Aaraga Gate

Figure 5.69: Showing the orientation of a menhir at Aaraga Gate

5.30 Vadakkipatti: The site at Vadakkipatti in Tanjavur District of Tamil Nadu was visited briefly just to compare the form of the boulder circles with the same elsewhere. The site is unexcavated and pottery and other cultural assemblages are found at the surface (Fig. 5.70). The interesting feature of this site is that laterite stone has been used for the boulders of the circle (Fig. 5.71) and they have been shaped into short arcs to go with the curvature of the circle (Fig.5. 72). No measurements were made at this site due to scarcity of time.

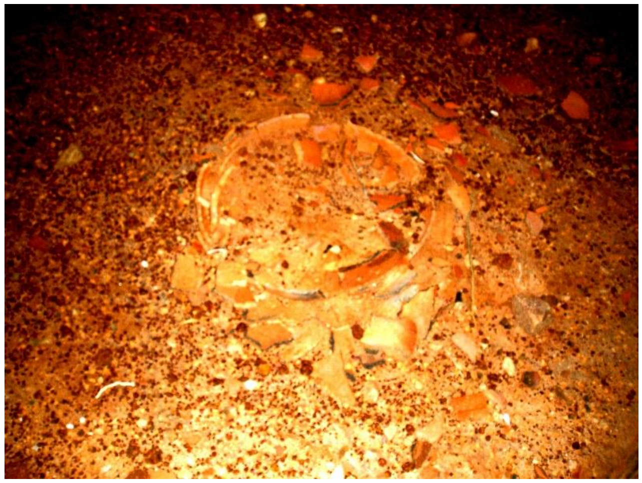


Figure 5.70: A surface find of pottery at Vadakkipatti

Figure 5.71: A laterite boulder circle at Vadakkipatti

Figure 5.72: A laterite boulder shaped to the arc of the boulder circle at Vadakkipatti

5.31 Junapani: Junapani near Nagpur in Vidarbha region was also chosen as a comparison site for the boulder and cairn circle typologies. Junapani is the second largest site in Vidarbha with 150 stone circles believed to date from Megalithic to Early Historic period. The site was excavated by Thapar (1961). Three stone circles were excavated and two of these had human remains along with other funerary objects and in one case, the remains of an animal from the Equidae (horse) family were found. All the circles seem to belong the same period. An unusual feature is the presence of a few cup-marked stones in the stone circles.

Figure 5.73: A large boulder circle at Junapani

The main feature of the Vidarbhan boulder circles and cairn circles is the large size compared to the southern counterparts studied at sites like Brahmagiri and Chikel Chetti (Fig.5. 73). The boulders themselves are very large and undressed, most probably field boulders rolled into place. The circles are very large, varying in diameter from 4m to 19m with most circles in the region of 12-13m.

5.32 Nagbhid: The site at Nagbhid was visited by chance, while studying Junapani and Champa. A visit to the Nagpur Museum revealed pictures of a menhir site in a region known mostly for its stone circles. The site is situated on a flat piece of land with a hill on the western side. There are 14 menhirs of sandstone slabs (Fig. 5.74) erected in the field, of which two are fallen and one is only a stump. It is evident that many menhirs may have been destroyed during the construction of quarters in the east part of the site. The menhirs seem to be distributed in a sort of grid and the long axes of cross-section of the slabs are oriented east-west. The site offers excellent comparison for the Nilaskal group of sites.

Figure 5.74: Three of the menhirs at Nagbhid

Figure 5.75: Three menhirs of Nagbhid seen from a tall construction in the east

Table 5.10: Summary of the orientations of the menhirs at Nagbhid (Corrected for magnetic declination for Nagbhid on date of survey = 0^o 34'W changing by 0^o 1'/year)

Menhir	Lat-Long	Orientation	Comments
1	20 34 39.6 79 40 08.4	-	Extreme north east menhir, one more fallen menhir beside
2	20 34 39.4 79 40 03.4	95^o	Extreme north menhir

3	20 34 38.5 79 40 02.5	96 ^{o}	In excavated area
4	20 34 38.3 79 40 03.2	102 ^{o}	Tallest menhir
5	20 34 38.3 79 40 04.6	-	Fallen menhir, large
6	20 34 37.8 79 40 03.2	82.5 ^{o}	
7	20 34 36.8 79 40 03.3	89.5 ^{o}	Inverted “L” shaped slab
8	20 34 37.0 79 40 04.4	101.5 ^{o}	Biggest menhir
9	20 34 36.4 79 40 03.3	93.5 ^{o}	
10	20 34 35.4 79 40 03.8	101 ^{o}	Broken stump
11	20 34 36.2 79 40 03.1	107.5 ^{o}	Small stump, broken at ground level
12	20 34 35.8 79 40 03.1	-	Fallen menhir
13	20 34 35.1 79 40 03.3	86.5 ^{o}	Pointed end; bird droppings!
14	20 34 29.7 79 40 10.1	-	Extreme south menhir

5.33 Champa: Champa is an unexcavated boulder circle and cairn circle site near Nagpur in Vidarbha region and was also chosen as a comparison site for the boulder and cairn circle typologies. There are a large number of boulder circles and cairn mounds bound by boulder circles (Fig. 5.76). The relevance of visiting Champa was realized when a “mini-cairn-burial”

(Fig. 5.77), which is a characteristic feature of many Vidarbhan sites, was identified at Byse in a recent visit (November 2011).

Figure 5.76: One of the cairn circles at Champa

Figure 5.77: A "mini-cairn burial" at Champa

The summary of main features and data from each site visited was presented above. The data presented in this chapter will be analysed in Chapter 6.

Chapter 6: Analysis, discussion of findings and conclusions

In this chapter, the data presented in Chapter 5 will be analysed and the results will be discussed. The conclusions of this investigation will be presented and prospects for future work identified.

6.1 Analysis:

6.1.1 Points of celestial significance on the horizon:

6.1.1 a. Points of the sun's cycle: First of all the points corresponding to the solar cycle on the local horizon for all the sites were considered. As explained in Chapter 2, the point of sunrise or sunset on the horizon moves between northern and southern extremes attained on the days of the summer solstice and winter solstice respectively. These days, the longest and the shortest of the year respectively, would be of importance to any culture following the progress of the sun in the heavens. The 2 days of the equinox – spring and autumnal, also could be of importance to such cultures.

The azimuth of the equinox sunrise points is always 90^{o} (cardinal east) irrespective of the latitude of a site and the azimuth of the equinox sunset points is invariably 270^{o} (cardinal west). However, the azimuths of the extreme northern and southern points of sunrise and sunset, corresponding to the solstices, are latitude-dependent. These extreme points of sunrise sunset can be found as follows.

The angular spread of these extreme points of sunrise is given by:

$$\alpha = 2 \times 23.5/\cos\varphi$$

where φ= latitude of the place. Thus for Nilaskal (Latitude 13^{o} 46' 36"N), the angular spread of sunrise would be 48^{o} 23' 32". Since this would be arranged symmetrically about the cardinal east and cardinal west points, the azimuths for summer solstice and winter solstice sunrises would be 65^{o} 48' 14" and 114^{o} 11' 46", and the azimuths for summer and winter solstice sunsets would be 294^{o} 11' 46" and 245^{o} 48' 14" respectively.

b. Points of the moon's cycle: The northern and southern limits of moonrise and moonset, and the method for their calculation, will be discussed here. These were considered with respect to testing of the alignments of the megaliths at Byse, as will be discussed in a later section.

It is well known that the Moon also has extreme points of rising and setting on the horizon and also that these extreme points themselves oscillate between extremes over an 18.6 year-long cycle (Ruggles 1999), as shown in Fig.6.1. These events are called lunistices – the major and minor standstills.

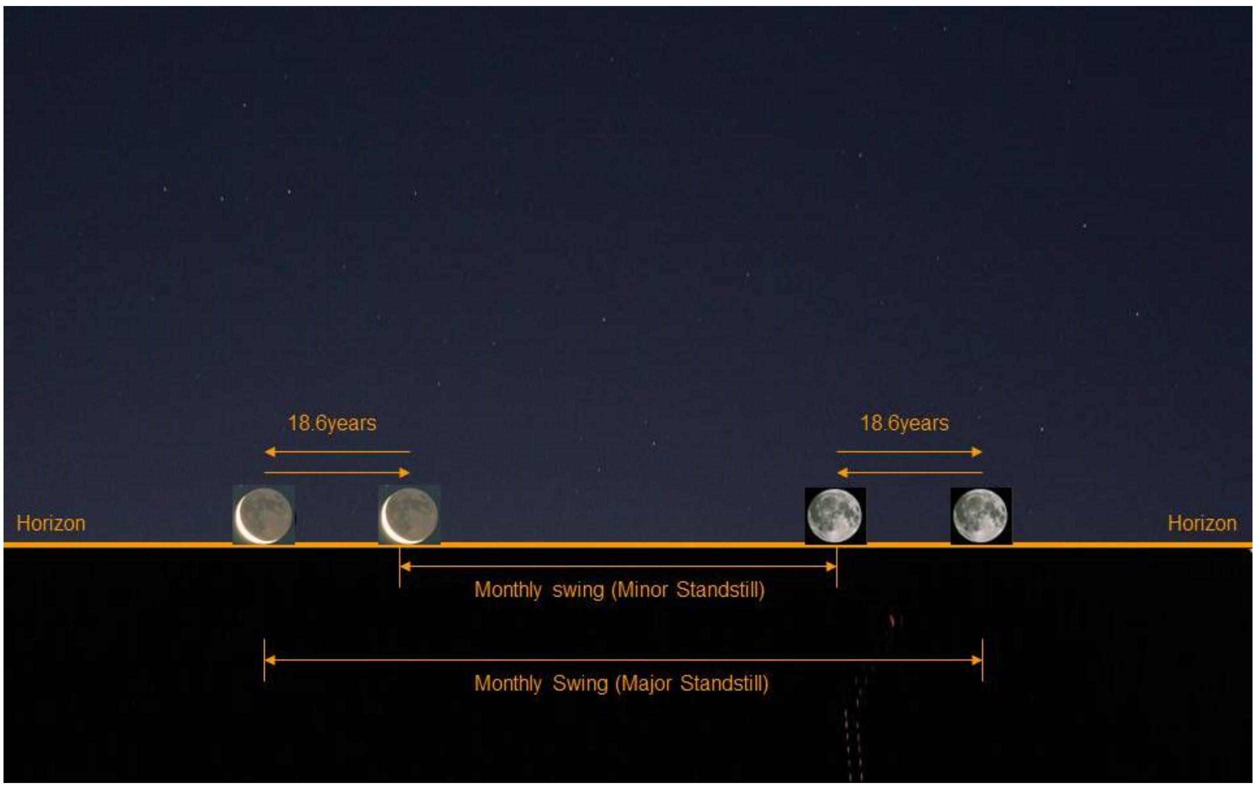


Figure 6.1: Showing the 18.6 year-long lunar cycle of major and minor standstills

The limits of the moon's rising points on the local horizon for a site with a latitude λ, the northern Major Standstill Lunistice limit is given by

$$\delta = +(\varepsilon+i) - P$$

where δ is the declination (celestial latitude), ε is the obliquity of the ecliptic (= 23^{o} .4), i is the tilt of the moon's orbit (=5^{o} .15) and P is a factor to be subtracted for Lunar Parallax (Ruggles 1999).

Similarly, the northern Minor Standstill Lunistice limit is given by

$$\delta = +(\varepsilon\text{-}i) - P$$

The southern Major Standstill Lunistice limit is given by

$$\delta = -(\varepsilon+i) - P$$

and the southern Minor Standstill Lunistice limit is given by

$$\delta = -(\varepsilon\text{-}i) - P$$

For Byse, disregarding P, we have obtained the values of δ for the above four limits as +28.55, +18.25 , -28.55, and -18.25 respectively. Converting to azimuths, we obtain 60^o 30' 54.68" and 119^o 29' 05.32" as the limits for Major Standstill moonrise and 71^o 11' 06.21" and 108^o 48' 53.7" as the Minor Standstill moonrise.

6.1.2 Analysis of the sepulchral and commemorative megalith types: In this section, the analysis of orientation of the cists, dolmenoid cists and dolmens at various sites will be presented.

a. Chikel Chetti: The orientation data for Chikel Chetti is not very strong. The intact cairns most probably have cists within, but the orientation of these cannot be measured. The orientation of the 5 exposed cists can be measured to a fair degree of precision, except in the case of cist 3a, where only one orthostat is extant. This seems to be a short orthostat, hence the bearing at right angles to this (290^o) is considered. Moreover, the direction in which the cists pointed cannot be ascertained since there is no porthole in any of the surviving orthostats. However, the orientation of the long axis can be analysed to see if it falls within the swathe of sunrise or sunset (just that one would not be able to conclude whether the tombs pointed to sunrise or sunset).

Table 6.1: Showing cist orientations at Chikel Chetti

Cist No.	**Azimuth (^{o})**
cist 1	258.5
cist 2	301
cist 3	290
cist 3a	283
cist 4	264

The swathe of sunset is between 246° to 294° for Chikel Chetti. This means that 4 out of the 5 cists would have faced sunset (or sunrise, depending on which orthostat had the porthole) on at least 2 days a year. Of course, a sample size of 5 is not sufficient to make any conclusions about intentional orientations.

b. Hire Benakal: The swathe of sunrise/sunset is 65.6° to 114.4° and 245.6° to 294.4° at Hire Benakal. Which means that (from Table 5.2) we can conclude that, out of 17 monuments whose orientations were studied, 6 would have faced sunrise and 5 would have faced sunset at some time of the year, while 6 monuments would not have faced the rising or setting sun ever. Clearly the data is not sufficient for a thorough analysis of preferred orientations, but the available data suggests that there was no preferential orientation to the solar directions.

c. The Thrissur sites: The swathe of sunrise/sunset is 66.1° to 113.9° and 246.1° to 293.9° at Thrissur. Thus (from Table 5.5), of the 9 rock-cut chamber orientations measured, 5 faced sunrise and none faced sunset, while 4 did not face either for any time of the year. Out of the 4 that did not face either sunrise or sunset, 3 are chambers adjoining other chambers that faced sunrise. Thus out of the 5 rock-cut tombs studied, only 1 did not have even a component chamber facing the sunrise/sunset. It can be safely concluded that the tombs were oriented to face sunrise.

At Kudakkallu Parambu, Cheramanangad, 2 of the 3 kudakkals measured had the joints of their clinostats aligned along axes consistent with the solar directions, while at Ariyannoor only 2 of the 5 kudakkals measured exhibited the same trend. Thus it can be concluded that the clinostats were not erected with any preferences as to their orientation.

d. Chik Benakal: The swathe of sunrise/sunset is 65.6° to 114.4° and 245.6° to 294.4° at Chik Benakal. Thus (from Table 5.8), of the 8 orientations that could be ascertained at the Chik Benakal site, 5 (including two marginal) pointed to sunrise during some day of the year while 3 did not. Once again, it cannot be concluded from the data available from the site whether there were any preferential orientations to the solar directions or any at all.

e. Aihole: The swathe of sunrise/sunset is 65.5^o to 114.5^o and 245.5^o to 294.5^o at Aihole. Thus (from Table 5.6) it is observed that, out of 16 orientations that could be measured with certainty at the Meguti Hill site, 7 point within the swathe of sunrise (or sunset, for those that lack porthole information) whereas 9 do not. In fact, all parts of the compass being represented uniformly, it appears that topographical, not celestial, criteria governed the orientation of the megaliths at Aihole.

f. Bachinagudda: Both the megaliths at Bachinagudda point south and as such do not point towards the sunrise or sunset at any time of the year. Two is not at all a sufficient number to draw any conclusions, but such is the nature of distribution of data at several megalithic sites.

g. Rajan Koluru: Rajan Koluru is the only one of the sepulchral sites to offer a definite conclusion about preferred orientation. Of the 45 orientations measured at the site, all point towards the south.

h. Kakkunje: The sole surviving dolmen at Kakkunje points towards sunset in the west. The collapsed dolmen has a porthole in the western orthostat suggesting that it, too, pointed to the west.

i. Konaje Kallu: Both the dolmens at Konaje Kallu point towards summer sunrise.

6.1.3 Analysis of the avenue/alignment sites: The approach to the analysis of the alignment/avenue sites was different. At Nilaskal and Byse – the sites where the measurement of the orientation of individual menhirs could be made, the pattern of orientation of these was studied. Wherever a map of the site could be prepared, i.e. in the case of the sites at Vibhutihalli, Nilaskal and Byse, sightlines for the significant dates of the solar cycle were tested. The results are discussed below.

a. Vibhutihalli and Hanamsagar: The site plan for Vibhutihalli is shown in Fig. 5.55. We tested the site for grid placement of the stones to the cardinal directions after correcting for magnetic declination (Fig. 6.2). The conclusion that can be reached is that the menhirs of Vibhutihalli are loosely aligned to the cardinal directions and to the 45^o diagonal. Of course, the individual menhirs being undressed boulders of varying sizes and shapes, no orientation of these can be measured.

For the other known avenue site of Karnataka – Hanamsagar, no detailed survey could be undertaken. However, based on our partial survey data (Table 5.7) and the photograph taken from the hill in the west (Fig. 4.2), it looks highly unlikely that the monument is a diagonal grid as suggested in Allchin (1956) and Rao (2005).

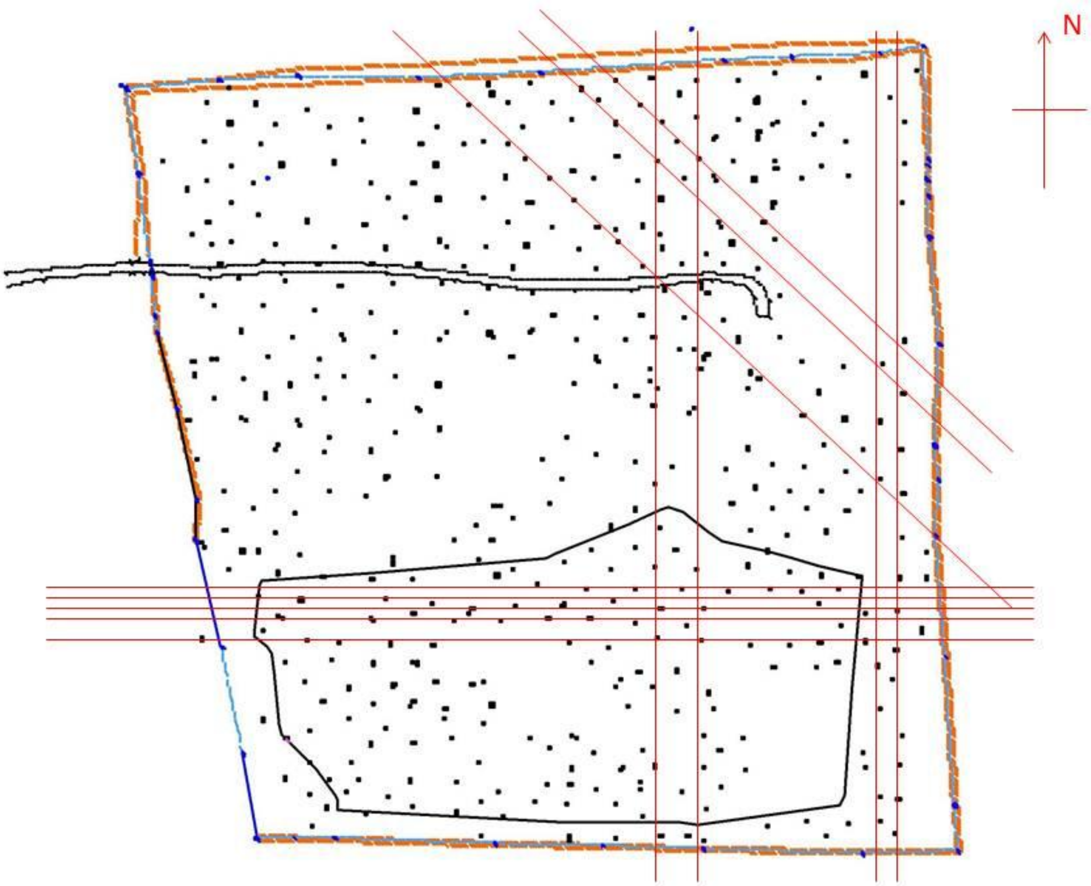


Figure 6.2: Showing the alignment at Vibhutihalli with N-S, E-W and 45° lines superimposed

b. Byse: The megalithic site at Byse consists of 26 menhirs – 13 of which are still standing, the rest being fallen, broken stumps or pieces. Many others may be missing. The largest menhir is 3.6m tall, 1.6m wide and 25cm thick (Fig. 5.24) and is worshipped as *Bhootaraya* under the prevailing local custom of ancestor worship. The site map of Byse derived from our survey is shown in Fig. 5.27. The menhirs are scattered in two clusters in an area roughly 60m (E-W) x 65m (N-S), in the northern portion of the clearing, though 20 of the 23 menhirs are in an area

30m (E-W) x 60m (N-S). The stones are mostly large undressed boulders of elongated cross section of granite. There are a few quarried slabs too.

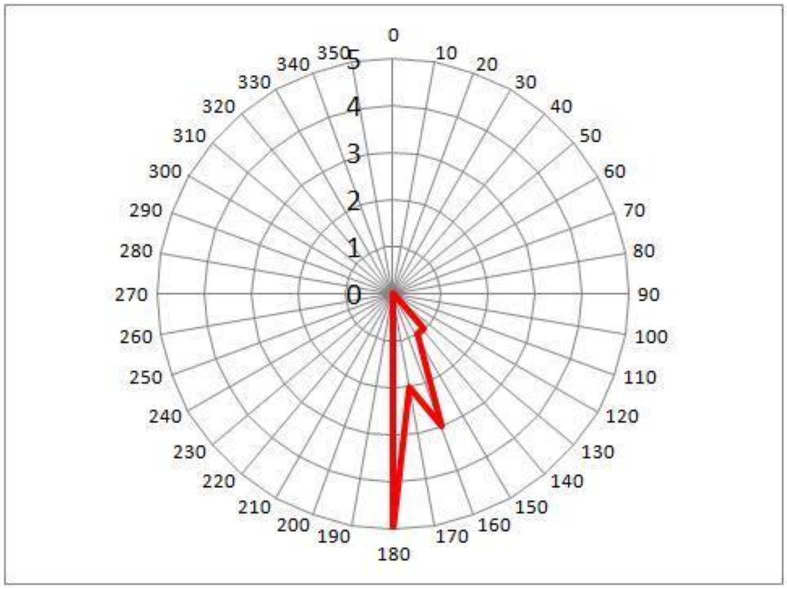


Figure 6.3: Showing the orientation of the standing menhirs of Byse

The survey of the stones was carried out with the aid of a prismatic compass with a least count of half a degree and a laser distance measuring device. The sizes and orientation of each standing stone was measured, as well as the position (bearing and distance) of each with respect to four reference points. Reverse readings were taken for the bearings so that any magnetic anomaly could be detected. The orientations of the long-axes of cross-sections of all standing stones were measured (as at the base). The orientations of the fallen stones were not taken into account while tabulating at the orientation of individual stones, which shows tight clustering in the N-S direction (Fig. 6.3). The horizon is visible in all directions from the site with the menhirs. The horizon is mostly gently rolling hills and largely featureless (see Fig. 6.4). There are no sharp peaks or features visible.

Figure 6.4: A view of the clearing at Byse and the horizon towards the north

Plotting the position of the individual stones on a site map produced what looked like two clusters of randomly located menhirs. Firstly, the arrangement of menhirs was tested for solar sightlines – involving stones that are within 2 ½ degrees on either side of the line to the setting/rising sun for the four solstice points, from each menhir. We have considered sunrise and sunset points on both solstice days. We have discarded stones F4 and Fr1, Fr2 from our survey which were considered too small – they could have easily moved far out from their original positions, being more susceptible to movement by human or animal causes due to their diminished size. The large standing stones are highly unlikely to have moved from their original positions and we have assumed that the large fallen stones too have fallen close to their original positions, as illustrated by the fallen piece and its stump for stone 8 (see Fig. 6.5).

When the arrangement of stones was simulated for shadow patterns on both solstice days, we found a distinctive pattern in the layout of these stones. Each of the menhirs is aligned with at least one other menhir during sunrise on either of the solstices and with a different menhir or menhirs at sunset. Fig.6.6 shows these alignments between the various menhirs on a site plan. Table 6.2 and 6.3 shows the list of back-sights, intermediate sights and fore-sights for the summer solstice sunrise and sunset respectively (which are the same as for winter solstice sunset and sunrise too). A disturbed cairn seen to the west of the southernmost stone has also been included in this list of alignments.

Figure 6.5: Showing stone 8 and its fallen part

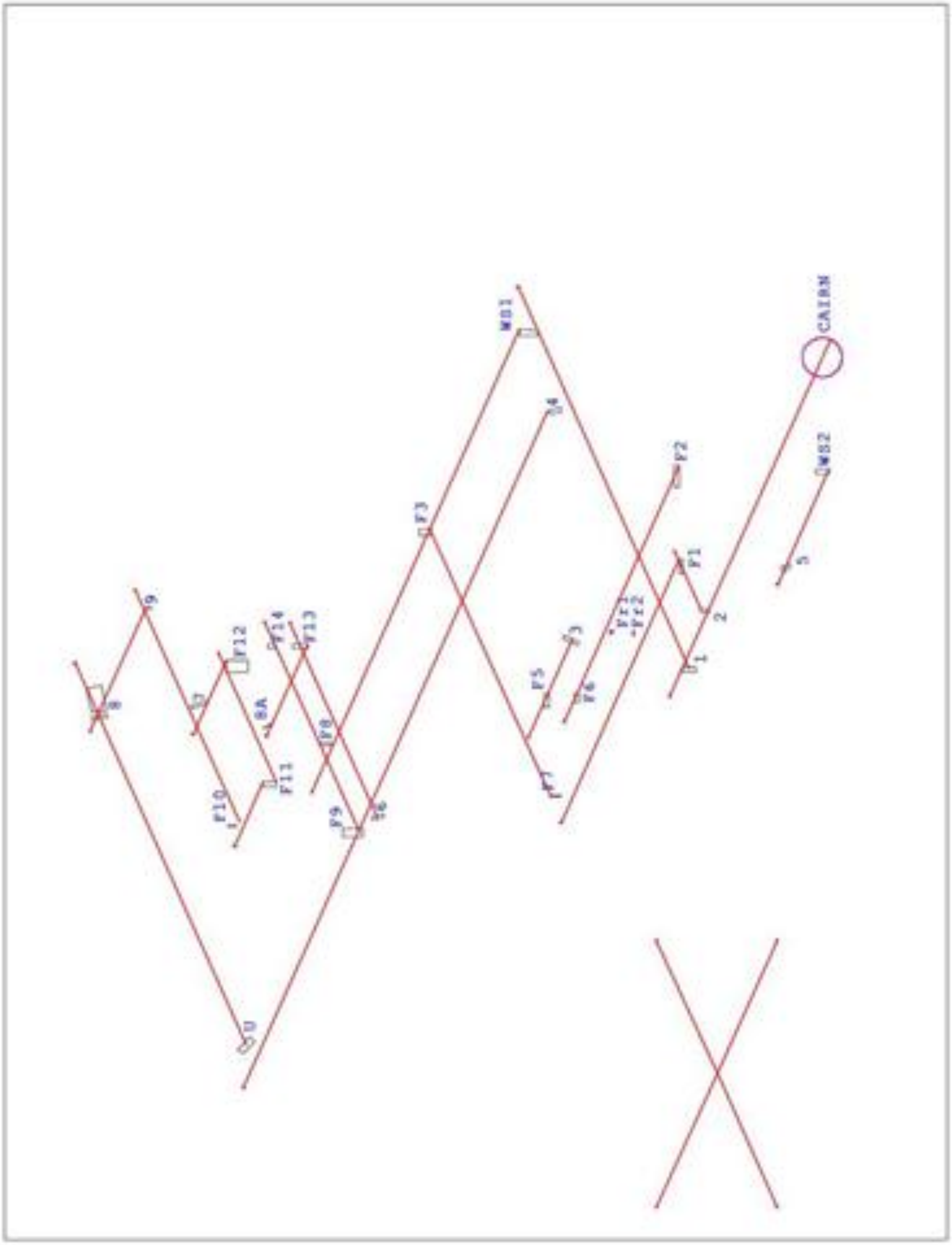


Figure 6.6: The sight-lines to the solstice sunrises and sunsets (N is to the left)

Table 6.2: The list of alignments for Summer Solstice Sunrise (Interchange fore-sight and back-sight for Winter Solstice Sunset)

S. No.	**Back-sight**	**Intermediate sight (if any)**	**Distance from back-sight (m)**	**Fore-sight**	**Distance from back-sight (m)**
1.	U	-	-	8	29.6
2.	F10	7	10.3	9	19.3
3.	F11	-	-	F12	10.1
4.	F9	F8	7.6	F14	16.9
5.	6	-	-	F13	15.4
6.	F7	-	-	F3	
7.	1	4	23.8	WS1	30.3
8.	2	-	-	F1	4.4

Table 6.3: The list of alignments for Summer Solstice Sunset (Interchange fore-sight and back-sight for Winter Solstice Sunrise)

S. No.	**Back-sight**	**Intermediate sight (if any)**	**Distance from back-sight (m)**	**Fore-sight**	**Distance from back-sight (m)**
1.	9	-	-	8	9.9
2.	F12	-	-	7	3.9
3.	F13	-	-	8A	7.0
4.	F11	-	-	F10	4.3
5.	WS1	F3	18	F8	37.7
6.	4	6/F9	36.8/38	U	57.7
7.	3	-	-	F5	5.0

8.	F2	Fr1	15.0	F6	20.7
9.	Fr2	-	-	F7	14.7
10.	F1	Fr2	7.2	F7	21.8
11.	Cairn	2	24.4	1	29.7
12	WS2	-	-	5	8.7

(Note: The Cairn, stones Fr1 and Fr2 have not been taken into consideration for any alignments or probability calculations and are shown in the tables only for records' sake.)

Thus the menhirs seem to be set out in a "solstitial grid". The accuracy of the alignments is less than 5 degrees centred on the sightlines, i.e. only stones that are within 2.5 degrees of a sightline on either side have been considered for selection as an alignment.

The menhir arrangement at Byse was tested for sightlines to lunar events on the local horizon, too. It is cautiously put forward that that the menhirs have lunar alignments too. We have checked for lunar alignments for the major standstill and minor standstill moonrises/moonsets for the latitude of Byse and have got a large number of alignments (see Figs. 6.7, 6.8). An important characteristic to be noted is that there are no menhirs that do not figure in any of the alignments, with most of them participating in all 3 alignments. The lunar sightlines have to be verified by a high-accuracy total-station survey at the site.

Thus a total of 38 solstitial alignments, 32 major standstill alignments and 36 minor standstill alignments for the 26 menhirs have been observed. Some of these alignments involve 3 menhirs while most involve only 2 stones. There seem to be 3-stone sightlines that "link" the two clusters together for the solar as well as lunar alignments.

The existence of so many parallel alignments to the same event on the horizon is curious and puzzling, and not encountered in discussions of prehistoric astronomy anywhere else. This type of layout is different from other instances of astronomical alignments found in megalithic monuments elsewhere, almost all of which involve a centre of observation for any given astronomical event on the horizon. Hence the conventional statistical examination to check if the observed alignments are intentional or not (Ruggles 1999) will yield a very low number as demonstrated below.

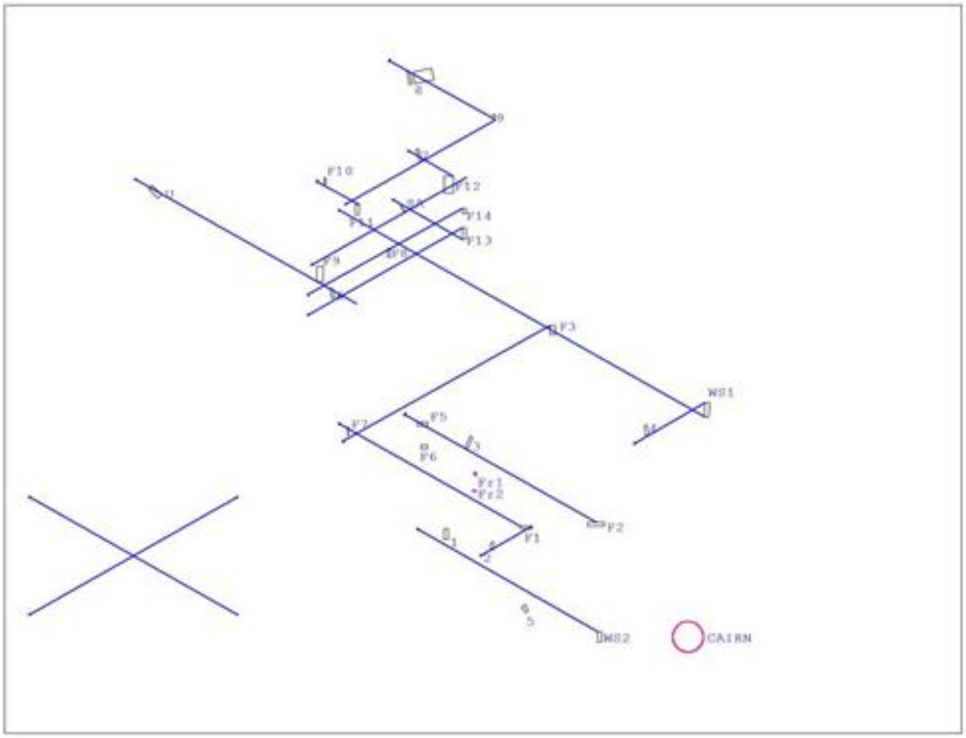


Figure 6.7: The sight-lines to the major standstill moonrises and moonsets (N is to the top)

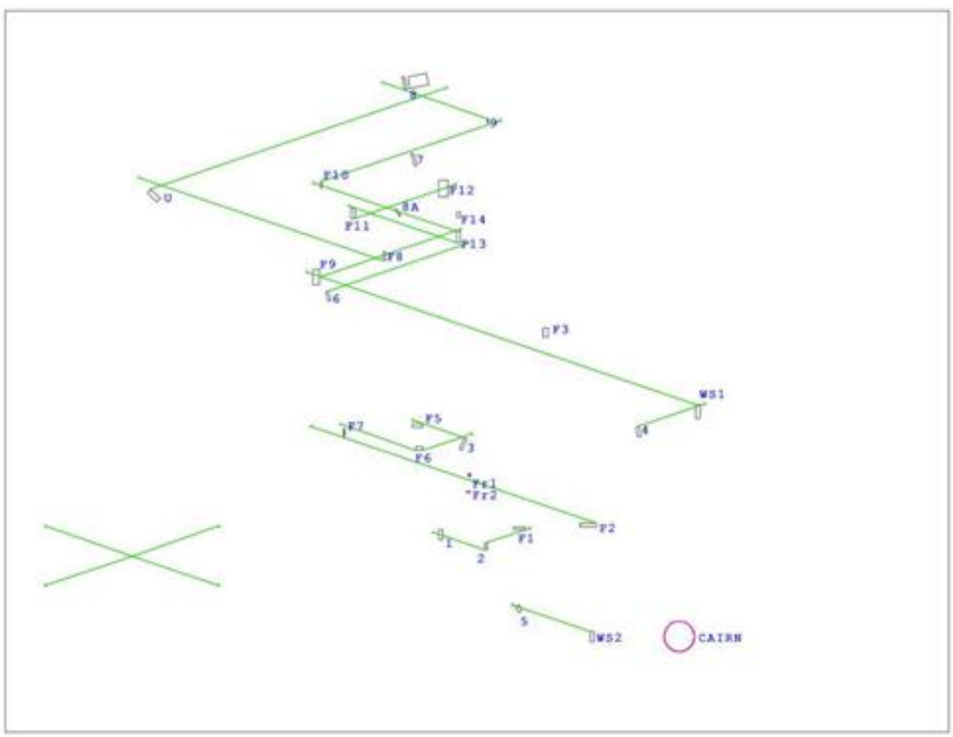


Figure 6.8: The sight-lines to the minor standstill moonrises and moonsets (N is to the top)

Conventional probability calculation: The two clusters were initially treated as separate. There are 13 stones in each cluster, standing or fallen, which we have considered for the sight-lines. Since either the north or south end of these have been considered, there are 26 points between which there are a total of 26C2 (=650) sight-lines possible, from which 26 is deducted since sightlines between points on the same stone cannot obviously be considered. The clusters were tested for the probability that the orientation to the solstice sunrise/sunset and lunistice moonrise/moonset points on the horizon could have arisen by random chance. The arrangements of menhirs have been tested for the observed alignments to 12 targets of 5° each on the horizon, out of a total of 624 alignments possible within each cluster, using the formula given below (Ruggles 1999).

$$P = 1 - \sum_{s=0}^{r-1} \frac{n!}{s!(n-s)!} p^s (1-p)^{n-s}$$

Where P is the probability that there will be at least r alignments to the solstices out of n possible alignments between all menhirs and p is the proportion of horizon occupied by the targets.

12 targets of 5° each have been considered, thus obtaining 60/360 = 0.167 for proportion of horizon covered by targets (p). The total number of combinations of points to make sightlines (n) is 624.

58 alignments have been identified for the north cluster (20 to the solstices, 20 to the major standstill lunistices and 18 to the minor standstill lunistices) and 44 for the south cluster (14, 14 and 16, respectively) as indicated in Fig. 6.9. The probability that the given number of alignments have arisen due to chance is 1 – (5×10^{-10}) for the north cluster and 1 - 1×10^{-7}) for the south cluster. Thus, by this method of calculation, it is highly unlikely that the observed alignments are intentional.

However, it can trivially be proved that even if a “solstitial grid” is designed, say, of a 100 pair of stones to point to each of the 4 solstice points, the above method will prove it to have arisen out of chance because all the sightlines – from each stone to every other stone will be considered. Hence we need to look at some other method to check this kind of site.

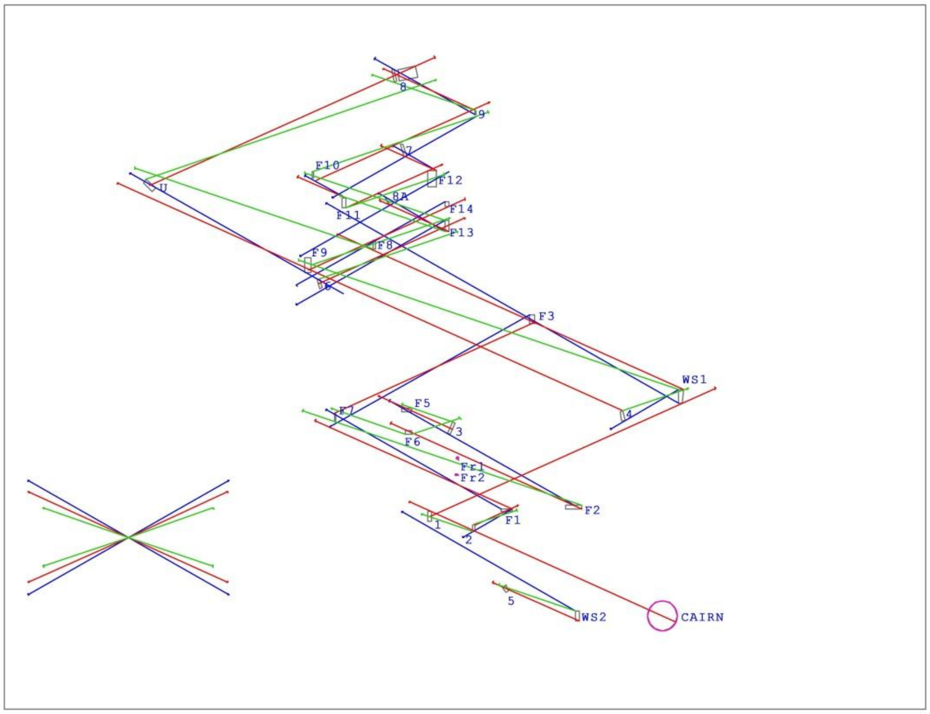


Figure 6.9: Showing all observed alignments at Byse

Ruggles (1999) discusses the strengths and limitations of the statistical method in the study of prehistoric astronomy. Apart from a host of issues such as limitations because of the quality of the evidence that survives above the ground, inability of such methods to discern practices that might have changed with time or from region to region or the various monument types, he also raises a more fundamental, though subtle, shortcoming of the statistical method: "The problem is that conventional statistical methodology is predicated on the assumption that a hypothesis is formed before data are acquired in order to test it. In practice, however, recognition of some pattern in the archaeological data always precedes the formation of a hypothesis, and the hypothesis chosen may in fact be one of several – indeed many thousands – of possibilities." "We have returned, of course, to the point that ideas and data necessarily and inevitably develop in parallel, and we have run into the problem that classical statistics lacks the theoretical framework to deal with this procedure in a rigorous way."

Alternative Method: Alternatively, it was examined whether the placement of the menhirs with respect to each other have any intentional order. In order to search for preferential sightlines, the

two edges of each of the stones were taken to be two separate points since the stones typically tend to be about a meter wide. A sightline formed by any two points is taken and it is assumed that any stone within 1 meter from the sight line belongs to the same sightline. The distribution of sightlines and the solstice points are given in Fig.6.10. The results are given in Table 6.4 which shows that the sight lines are intentional rather than chance alignments. There are 2 sightlines of 7 stones that point 11^o West of North. The significance of the result does not change even if the midpoint of each stone is taken as the location. The alignments were also tested assuming each stone as a single object and the results are as expected (Table 6.4). The most important are two sightlines in 142^o – 318^o direction and 172^o – 348^o with 16 and 14 lines pointing in these directions. Important stars that set at 348^o in 1000 BC are Arcturus, Vega, Deneb and Capella while Regulus and Pollux set at 318^o. However, stellar alignment interpretations are not made because of the large uncertainty of maybe as large as 2,500 years in dating the monument.

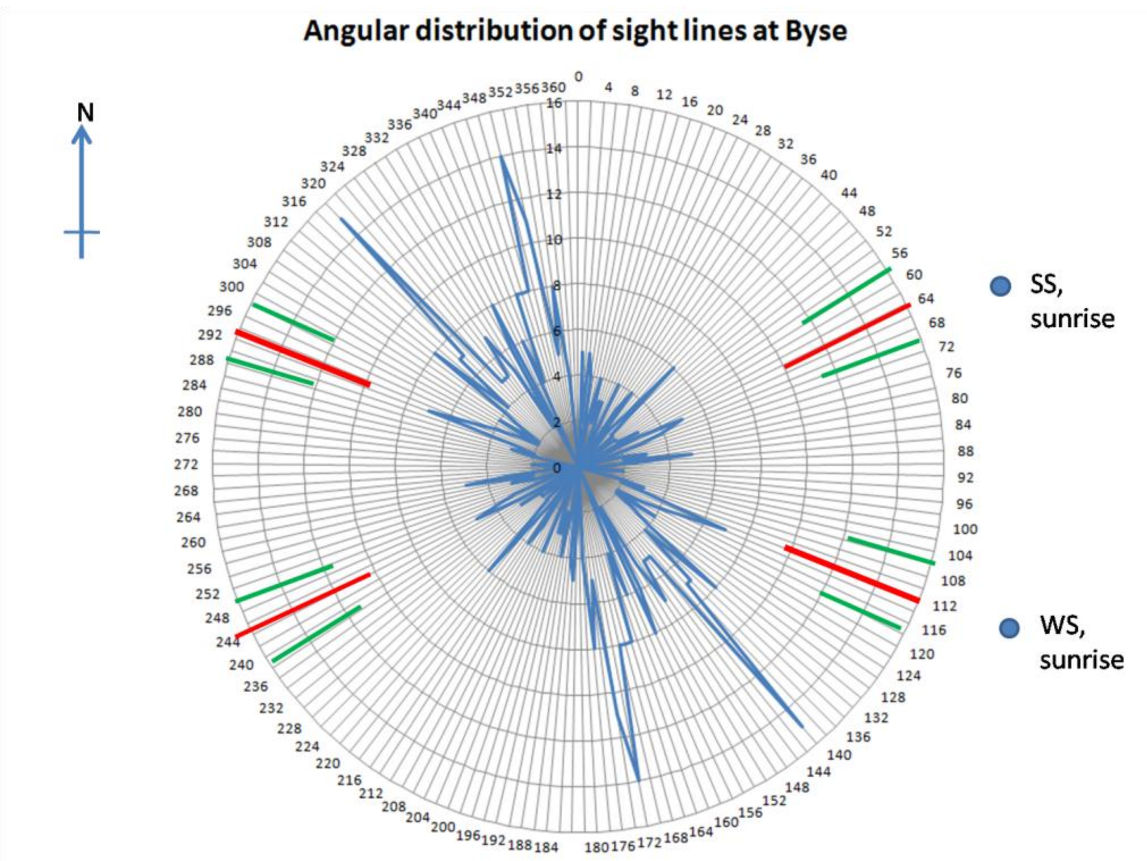


Figure 6.10: Showing the distribution between pairs of stones at Byse

Table 6.4: Showing the number of k-stone alignments expected by chance versus that actually observed for k = 2 to 7

No. of stones	Taking each edge of a stone as separate point		Taking mid-point of each stone	
	Expected by chance	**Observed**	**Expected by chance**	**Observed**
1	325	325	78	78
2	5.2	140	0.158889	13
3	0.0598	29	0.000221	1
4	0.000526	12	2.21E-07	1
5	3.68E-06	0	1.63E-10	0
6	2.1E-08	2	9.08E-14	0
7	325	325	78	78

This shows that there was a definite intention behind the placement of the stones and that they were not arbitrarily erected, and in conjunction with the observed alignments to the solstices and lunistices, it can be concluded that the placement of the menhirs at Byse had an astronomical basis.

c. Nilaskal: Nilaskal is situated about 7km from Nagara by road and is nearly 66km due south of Byse as the crow flies. This is an extensive and impressive site with the remnants of nearly a hundred menhirs, some of them still standing, spread out over an area of approximately 100m E-W x 300m N-S. A road running from north to south divides the site into two unequal halves and some of the menhirs have obviously been destroyed by a school building in the northern part of the site and residences in the eastern side of the road. Some of the menhirs are inside a plantation adjacent to the school in the northern portion of the site, but most of the prominent menhirs are in a clearing in the western portion that constitutes the largest part of the site. Fig. 5.21 shows the satellite image of the site and surroundings. The largest menhirs at the site are roughly 3m wide at the base and 6m high, but only 25-30cm thick. One of these is adjacent to the road (Fig. 1.10) and the other is in private residential property in the eastern portion (Fig. 5.22).

The terrain slopes gently upwards to the west and thus forms an artificial horizon towards the west (Fig. 6.11). To the east, the horizon is unobstructed except for trees and other vegetation that, presumably, are recent.

Figure 6.11: Looking westwards from near the road showing the artificial horizon created towards the west

As mentioned earlier, the remnants of nearly a hundred stones have been found during this study at Nilaskal. There is severe disturbance in several parts of the site – in the north, where a school has been built; in the south where earth has been excavated in a large area; in the north-east and east where a residence has been built etc. Among the stones still standing, we have estimated that 25 of the stones appear to be in the position that they were originally erected in (Table 6.5). This is due to their large size and the manner in which they are embedded in the ground. The largest menhirs shown in Figs.1.10and5.22as well as the menhirs comprising the alignment shown in Fig.3.26, fall into this category. We have prepared a photographic database for all the stones surveyed at Nilaskal; a sample entry for the biggest menhir is shown in Fig. 6.12.

Figure 6.12: Sample entry from a photographic database of all the menhirs of Nilaskal - stones are photographed from the east, south and west (Stone no. from old survey, new survey no. 74)

Table 6.5: Showing the stones which appear to be in the position they were originally erected in

No.	Stone No.	Status	Size Class	Remarks
1	16	D		
2	18	D	GIANT	Sharp-tipped Stone
3	25?	H		
4	32	D		Split stump.
5	40	H		
6	43	H		
7	49, 48	D		
8	57	H		
9	68	D	GIANT	
10	69	D	GIANT	
11	71	D		Lorry-broken stone; take N-stone as original position
12	72	D	GIANT?	
13	73	D	GIANT	
14	74	D	GIANT	Biggest menhir at Nilaskal, near Road

15	75	D	GIANT	At grove border, in 2 pieces; S-stone as original position
16	77	D	GIANT	
17	81	D	GIANT	Chisel marks; piece broken by vandals?
18	82	D	GIANT	Quasi-anthropomorph
19	83	D	GIANT	Thick
20	85	D	GIANT	Known locally as "Karnataka Map"
21	88	H		
22	92	H		In Nagesh's compound
23	94	D	GIANT	In Manjunath's compound; big stone
24	95	H		In Manjunath's compound
25	96	D	GIANT	In Nagesh's compound; 2^{nd} largest menhir

NOTE: D – definitely and H – Highly Probable, that the stones are in their original positions

The remaining stones are fragments and smaller stumps and have been broken by residents to serve as building material etc. Many of the smaller stones or broken pieces may not be in the position they were originally erected in and a few appear to be spurious – not from any menhir that was part of the monument; a list of these stones is given in Table 6.6.

Table 6.6: List of stones whose positions are Unreliable and those that appear Spurious

No.	**Stone numbers**	**Status**	**Remarks**
1	12 (?)	Unreliable	
2	20 (?)	Unreliable	
3	21 (?)	Unreliable	Looks like a fragment, but embedded; in bush
4	24	Unreliable; spurious?	
5	33	Unreliable?	
6	37	Unreliable?; Spurious?	
7	41, 42	Spurious	Different material? Loose
8	44, 45	Spurious	Different material? Loose

9	46	Spurious	
10	50, 51	Unreliable?	
11	56	Unreliable?	
12	62	Unreliable	Large broken piece with chisel marks
13	66, 67	Unreliable?	Fragments? May be left out?
14	70	Unreliable?	Large fallen stone by road
15	76	Unreliable?	
16	78	Unreliable?	Fragment; may be left out?
17	79	Unreliable?	Broken piece
18	80	Unreliable?	Broken piece
19	84	Unreliable	Large fallen stone by road inside school compound wall
20	86	Unreliable	Fallen; placed next to school building
21	87	Unreliable?	Large stone; moved? W of Nagesh's house adjacent house wall
22	89	Unreliable?	Large stone; moved? W of Nagesh's house near tree & compound wall

In addition, some of the other stones look like fragments or pieces broken off from standing stumps of menhirs, or parts of a single destroyed menhir (Fig. 6.13). A list of such stones is given in Table 6.7.

Table 6.7: List of stones that look like they were part of one stone originally

No.	**Stone Nos. (From Total Station Survey)**	**Remarks**
1	0, 1, 2, 3, 4, 5, 6, 7(?), 19(?)	Closely located fragments
2	13, 14	13 original position, with 14 fallen?
3	22, 23, 24(?)	24 is a loose stone, can even be left out
4	25, 26	25 original position?
5	28, 29	Broken, closely located
6	34, 35, 36	Broken, closely located

7	37, 38, 39	Broken, closely located (37 may be left out)
8	48, 49	49 original position?
9	50, 51	Broken, closely located
10	52, 53, 54, 55	Closely located pieces
Note: Probably Stone nos. 50-58 came from only 2 stones; original positions 57 and 55???		
11	60, 61, 62, 63, 64	Broken, loosely scattered
12	76, 77	77 in original position for sure; 76 piece off it?
13	79, 80, 81	Take 81 only?
14	90, 91	90 original position?

Figure 6.13: Showing menhirs 13 and 14 which were probably part of one stone originally

Due to the nature of the site and the conditions of many of the menhirs and the large number of fragments, many of which may come from the destruction of a single menhir, performing the kind of statistical analysis done with Byse would not be possible. Also, looking at the scattered nature of broken pieces and fragments, we could arrive at erroneous results if sightlines were detected considering every remnant on the site. Hence alignments involving at least one the 25 stones of Table 6.5 were only considered for the solstice sunrises/sunsets, as shown in Map 2.

A topographical analysis of the site was done (Fig. 6.14) and the sightlines observed in plan were validated as topographically viable. This is very important since the site has a slope as shown in the figure. A very important characteristic of the site that was noted was that none of the menhirs were located beyond the highest point of the slope (Map 1, 2) – which lends credence to the possibility that they were meant to act as a reference point for events that were happening in the sky.

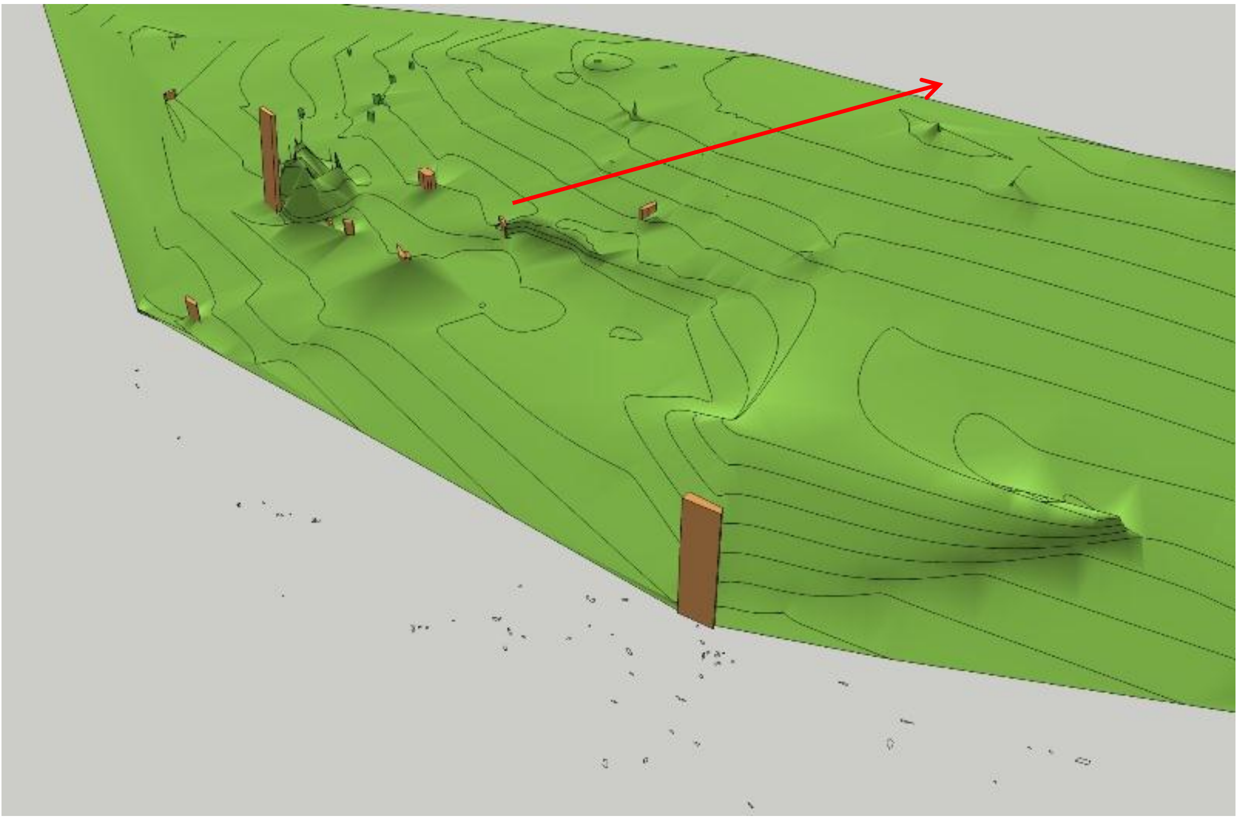


Figure 6.14: Showing validation of the sightline shown in Fig.55

However the long sightlines observed here, some involving even 4 stones all are viable sightlines as permitted by the topography. The sightlines observed were validated at site too, by measurements by prismatic compass as well as photographic recording at or near winter solstice (Figs. 6.15, 6.16).

Figure 6.15: Sightline between stones 69 and 18 framing the setting sun at winter solstice

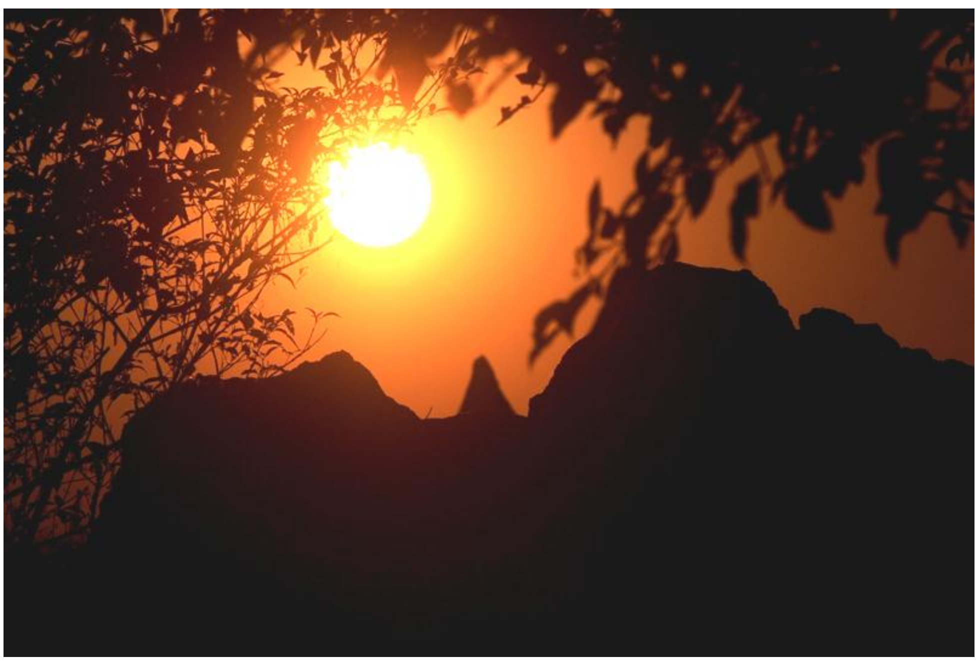


Figure 6.16: Sightline between stones 68 and 28-29 framing the setting sun close to winter solstice

The orientation of the individual menhirs of Nilaskal too followed the trend exhibited by those at Byse – tightly clustered about the N-S orientation (Fig. 6.17).

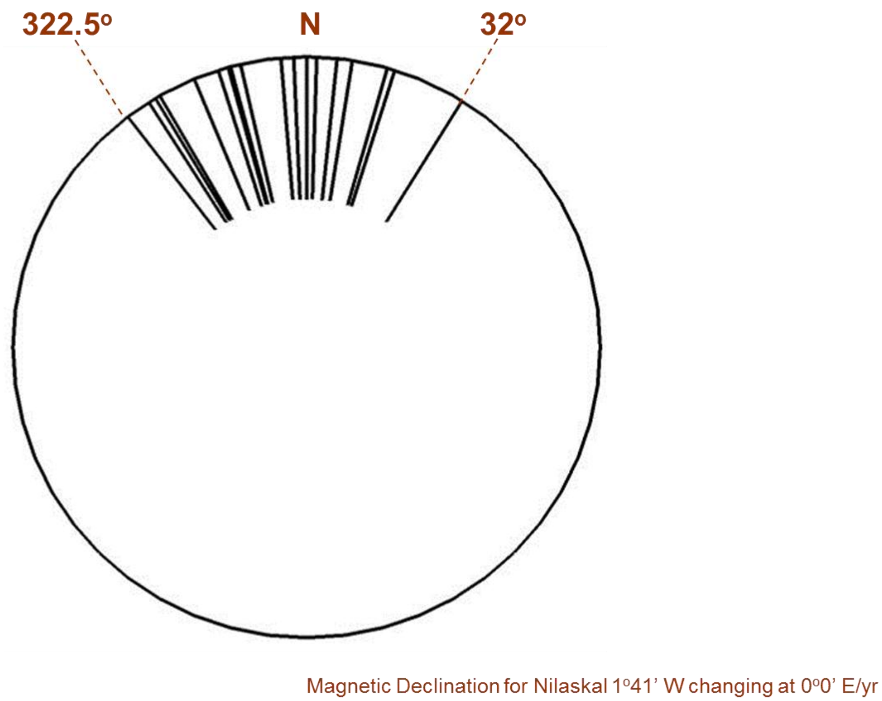


Figure 6.17: Showing the orientation of individual menhirs at Nilaskal

d. Nagbhid: The megalithic site at Nagbhind (20°34'38,3"N, 79°40'03.2"E) in the Vidarbha region consists of several menhirs made of sandstone (Figs. 5.74, 5.75). We were surprised to detect a similar pattern as found in the Nilaskal-Byse type of alignment, except for the fact that here the individual menhirs are oriented E-W with their faces looking north and south.

The site has 14 menhirs, of which two are fallen and another two are broken stumps. We have not yet surveyed this site, but a check of bearings with a prismatic compass has confirmed that the orientations of the individual menhirs are tightly clustered around E-W and that a pattern is evident (Fig. 5.75). Several menhirs are missing with a housing colony obviously encroaching on to the site in the east. A prominent hill dominates the skyline to the west of the menhirs, thus ruling out any sightlines to the west, but the eastern horizon is unobstructed, except for the buildings of the housing colony.

From the above analysis, a strong possibility that the sites at Nilaskal and Byse were laid out with an astronomical theme emerges as a distinct possibility. It is likely that similar sites may be found elsewhere. The results of the analysis of all the studies of this investigation are discussed below.

6.2 Results and discussion: The results of the above analysis and their interpretation in the light of currently prevalent understanding of Indian megalithic culture and architecture are discussed below.

6.2.1 The sepulchral/commemorative megaliths: The results indicated by the parts of this study that dealt with sepulchral/commemorative megalithic architecture suggest that the traditions of orienting dolmens, dolmenoid cists and cist burials were dependent upon region and, probably, chronology. A properly resolved picture can emerge only if a concerted effort to measure the orientation of all Indian megalithic tombs on the scale of Hoskin (2001) is undertaken and also, the chronology of the Indian megaliths are established on a proper footing – both of which fell beyond the scope of this investigation.

The pitfalls and dangers of "stylistic dating" of monuments is well understood, but given the lack of a proper chronology to date the Indian megaliths, it offers the only way out in the quest for a rough framework for chronology. For instance, if one were to associate better understanding of stoneworking to be evidenced by the ability to quarry, by firing or any other method, thinner and larger slabs of stone, one can conclude that the dolmens of the central group at Hire Benakal are older than the dolmenoid cists and other megaliths at the site, which may have been in use for many generations. By the same logic, the rock-shelter chambers and IPC's may be the oldest monuments of the group. This could well be proved wrong if there were evidence that the tall dolmens were the sepulchres or memorial of important personalities/clans and economics was the driving criterion for the scale, design and finish of the monument. Support for the former argument comes from the observation that the swastika-style interlocking of orthostats to prevent inward collapse seems to be prevalent in the "later" groups of monuments like the cists of Brahmagiri, dolmens and dolmenoid cists of Hire Benakal and the dolmens of Kakkunje, Konaje Kallu etc. which have better quality of stone-working skills evident both in the extraction and processing of stone. In comparison, the megaliths of Meguti Hill, Aihole and Rajan Koluru seem "older" due to the unwieldy nature of the slabs used and the rough finish of the stone monuments, including the excision of portholes. The feature of the polished porthole at Konaje Kallu and the shaping of curved orthostats at Kakkunje most probably points towards a later date of erection for these than their counterparts at Hire Benakal and elsewhere (Fig. 6.18).

Going by this admittedly ad-hoc method of stylistic dating, it would appear that the oldest monuments were either oriented by topography as possibly at Aihole or were oriented southwards as at Bachinagudda and Rajan Koluru. Later monuments showed a tendency to be oriented east- west, such as at Konaje Kallu or Kakkunje. Hire Benakal is a very interesting case since it contains a large number of monuments most probably erected over a large period of time. A thorough survey of the site and its monuments with an analysis of the orientation preferences of each type of monument would be very useful in solving this problem. With the current data, it is tempting to paint a neat picture of the earliest tomb-types to be oriented by criteria other than the cardinal directions, followed by the emergence of south-facing tombs. Later traditions seem to switch over to east-west oriented and sun-facing orientations. This is a widely prevalent view among eminent workers in megalithic studies (Sundara, *Pers. Comm.*), however it must be admitted that it is difficult to support or negate this with the data available.

Figure 6.18: Showing porthole styles from Rajan Koluru, Aihole and HireBenakal with th epolished porthole of Konaje Kallu in the centre

It is indeed regrettable that the specimens of human bones recovered from some of the dolmens by Meadows-Taylor (1853) were destroyed before dating of such material became possible and commonplace. Today, almost all dolmens because of their exposure above the ground and subsequent susceptibility to looting have no funerary remains associated – a fact that has caused them to be listed as non-sepulchral monuments in some classification systems.

In the same manner as above, it is possible to date the burial caves at Kakkad (Fig. 6.19), Kandanasserry and Kattankampal as later than the cave at Eyyal and maybe Chowwannur due to the fine quality of laterite work evident at those sites.

Figure 6.19: A finely worked laterite bench at the rock-cut cave at Kakkad

6.2.2 The avenue/alignment sites: Prior to this study, alignment/avenue sites were believed to be confined to North Karnataka and Andhra, with very few outliers elsewhere (Fig. 3.13). By the detection of a pattern to the layout of Nilaskal and Byse, and the observation that it is highly probable that the sites at Heragal, Mumbaru and Aaraga Gate also are laid out to the same pattern, the geographical distribution of alignment/avenue sites have been extended to southern coastal Karnataka, too.

This study has shown the known alignment site of Vibhutihalli to consist of unshaped boulders loosely aligned to the cardinal directions and the diagonal, the large numbers of stones probably offsetting the lack of precision in the setting out of individual stones. Megalithic monuments such as these could very well be the oldest alignments – Sundara (1975, p. 166) mentions that they may not belong to the south Indian megalithic complex at all; they were classified as megalithic because of the use of lithic material of large scale and because of the presence of megalithic cairns etc. in the surrounding regions. Monuments such as those at Vibhutihalli and Hanamsagar are situated in regions with a history of human occupation from very early times and rich in Neolithic remains like ashmounds etc. So it is quite likely that these monuments are the earliest type of alignments.

Once again leaning on the crutch of stylistic dating in the absence of any other handles on a proper chronology, it would appear that the alignments at the 5 south Karnataka sites studied in this investigation, with their use of elongated boulders or dressed slabs, postdate the alignments at Vibhutihalli and Hanamsagar, which use unshaped field boulders of varied sizes and shapes. This is in agreement with the better precision in the positioning of the menhirs at the Nilaskal group of sites.

These five menhir sites – Nilaskal, Byse, Heragal, Mumbaru and Aaraga Gate have emerged as a clearly distinct typology after our surveys at Nilaskal and Byse. They are distinct from the stone alignments of north Karnataka and Andhra Pradesh mentioned by Allchin (1956) like Vibhutihalli, Hanamsagar etc. which use rounded boulders of varying shape and are usually undressed.

Nilaskal is easily the type site for the new kind of alignment established by this investigation. The clever selection of a site with the right topography, the sheer extent of the site and number of stones of large magnitude used and the precision with which these slabs have been handled and erected all testify to this, just as Hire Benakal was made the type site of the several sites of similar typology in that region in the study by Sundara (1975). The sites at Nilaskal and Byse exhibit clear-cut connections with at least solar astronomy. It has been proved earlier in this chapter that the site at Byse has been laid out to an intentional pattern and that there are definite correlations with the directions of sunrise and sunset during both the solstices and perhaps for the lunistices too.

The detection of a pattern at Nagbhid that could be similar to the Nilaskal-Byse typology is quite exciting and could extend the geographical range of distribution of these alignments. It is imperative to examine all the known menhir sites for layouts that are along similar lines. The five sites of south Karnataka are in a similar latitude range, so that the swathe of sunrise and sunset on the horizon are similar for all of them. In this connection, study of similar monuments at considerably different latitudes would confirm beyond all doubt whether the orientations to solstices and extreme points of moonrise/moonset are indeed intentional – since these points would have different azimuths at these locations. Thus we can rule out any other, local, criterion that could have decided the layout of the south Karnataka sites. It is in this context that the site at Nagbhid is very important, as may be other sites of similar typology, if found.

Looking at the south Karnataka sites, it is tempting to speculate on their relative antiquity based again on stylistic and other grounds. For instance, the presence of a large number of quarried slabs, some of them very large, at Nilaskal, as well as the extensive nature of the site with possibly much more than a hundred stones originally, might be an indication that Nilaskal was a grand culmination of this series of sites. The earlier sites may have used natural boulders of the required shape erected in position and as the experience of working with stone grew, as also familiarity with the kind of phenomena being observed, larger and more sophisticated layouts could have become possible. The selection of a site like the one at Nilaskal with a gently sloping east-facing slope rather than the flat sites elsewhere may also indicate sophistication of observing celestial phenomena with a raised horizon that obviates the increased optical extinction associated with the real horizon. This is possible only for sites close enough to the equator, otherwise the azimuths of the bodies would be considerably different if observed higher up in their diurnal arc. It is also possible that some of the sites assumed their present form and layout over a large period of time which would account for the presence of a mix of natural boulders and quarried slabs among the menhirs.

Of course these are all conjectures that are highly biased by our current way of looking at astronomy and can be verified only with a comprehensive study of these sites from the archaeological perspective.

As regards Nilaskal, the characteristics of the site and the menhirs that help to firmly establish the astronomical hypothesis are:

1. The appearance of the elevated ground to the west as an artificial horizon on which celestial phenomena can easily observed free of possible obstructions and the increased atmospheric extinction that mars observations close to the true horizon.
2. The fact that none of the menhirs are located beyond the highest part of the land in the west. This is a clear indication that visibility up to the artificial horizon created was the only consideration.
3. The taller menhirs are located downhill to the east and the shorter ones are on the higher ground.
4. The presence of what appear as notches for observation on several stones, most prominently on stone 68 (Figs. 6.16, 6.20, 6.21, 6.22)

Figure 6.20: Looking east from menhir 68 at Nilaskal, one can see two other menhirs through a notch

Figure 6.21: Looking westwards from the same menhir, one sees another through the notch; note the raised horizon too

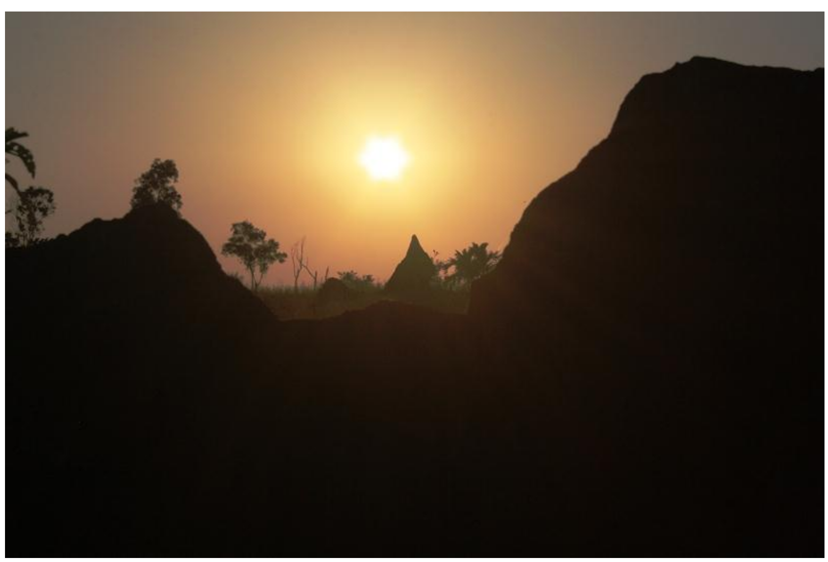


Figure 6.22: The setting sun near winter solstice as seen from the same point as in Fig.6.21

One of the criteria for the selection of all these sites seems to have been a clear view to the horizon, unobstructed by topography (the only exception being Nagbhid – where the horizon to the west is obscured by a hill). The alignments to celestial phenomena on the horizon, if that indeed was the intent of the monuments, could not have been of extremely high precision since there are no horizon markers that could have served as foresights that permit such precisions. However the erection of an extensive site like the one at Nilaskal, as opposed to the smaller ones at the other four sites nearby, could have been out of the need to have longer sightlines that permit greater accuracy. This also ties in with the fact that Nilaskal has larger number of quarried slabs and bigger slabs that require greater skill in extraction as well as erection.

The significance these alignments had for the megalith builders is not clear. If these were indeed "observatories" to mark time by observing celestial cycles, why would there be so many parallel sightlines to the same phenomenon? All other known megalithic sites of the world that have been found to have associations with astronomy, such as Stonehenge (Osborne 1995) or Avebury (Wheatley and Taylor, undated, p. 14) in England, have well-defined centres of observation from where the observer can see celestial phenomena as indicated by foresights. Even the several sites of Brittany that were associated with lunar astronomy by Alexander Thom (Hadingham 1983) had the huge menhir called "Men er Hroeg" as a common foresight. The sites at Nilaskal and Byse are the only known cases where there are multiple sightlines to the same phenomena.

Again, why the proximity of these alignments to sepulchral megaliths, at least in the case of Byse? There are traces of cairns among the menhirs at Byse, including a "mini-cairn burial" like the ones at Champa near menhir 1 and a disturbed cairn east of the southernmost stone in the alignment as also several intact, unexcavated large cairns in the clearing south of the menhirs which seem to have definite sepulchral connotations. The southernmost menhir at Byse and the largest menhir at the site are worshipped by the local population as part of ancestor worship (a practice that may be culturally discontinuous from the culture that erected the megaliths). A deep excavated area in the south has unmistakable signs of quarrying, perhaps for the slabs that became few of the menhirs. Though dry, this is reminiscent of the practice of using the quarry area as a modified water body in sites like Hire Benakal and Meguti Hill, Aihole.

There are also two *virakals* or hero stones (which are memorial stones of dead heroic personalities erected in later, historic periods) south of the menhirs. The virakals and the mounds

in which they are found bear striking similarity to the known tombs (*samadhis*) of the rulers of the Nayaka dynasty that is found within a few km of the megalithic site. It is possible that the palatial mansion that had existed at the Bungle Gadde right adjacent to the megalithic site belonged to this dynasty and the two virakals mark sepulchres of Nayaka personalities, which indicates a re-use of a portion of the megalithic site for similar sepulchral activity just 500 years ago.

Figure 6.23: One of the Virakals in the south at the Byse site

All these sepulchral connotations seem to link the menhirs too with a cult of the dead, though the connection between the two can only be guessed at.

6.3 Conclusions: At the end of this investigation, which had several strands of enquiry but was based on surface observations alone (without any component of excavation) of megalithic sites, there are conclusions drawn about several aspects of the design and construction of megaliths, which are recounted below.

6.3.1 The sepulchral architecture of the megalithic times: After investigating the handful of sites, it can be concluded that the practice of orienting the sepulchres/commemorative dolmens etc. differed from region to region and possibly changed over time, too. Conclusions about relative chronology of the various sites and also monuments within the site has been attempted based on refinement of design and construction skills, development of structural systems, refinement in the conception and execution of details like portholes etc. It would be interesting to compare this chronology based on "stylistic evolution" with a hard framework of radiocarbon dates when such a picture might eventually emerge for the Indian megaliths.

Another finding was the fact that many of the menhirs in Karnataka, too, are sepulchral, like their counterparts in Kerala. Some of the menhirs at Byse had cairns associated with them (Fig. 6.24), which seem distinctly sepulchral in nature, though only an excavation can confirm this. Hence it is felt that menhirs may have served different purposes depending on context and overarching sweeps of classification may not serve the purpose of true understanding of the nature of the various types of megaliths. Menhirs could have served as markers for burials, or as commemorative pillars or as markers for the land or the sky. It is likely that sepulchral menhirs also were laid out to patterns dictated by celestial concerns.

Figure 6.24: The disturbed cairn (in the foreground) east of the menhir worshipped as *Rana* at Byse

6.3.2 Stone alignments and astronomy: There is a distinct class of stone alignment in southern Karnataka and possibly other places in the range of occurrence of megaliths in India that have definite astronomical significance. Intentional alignments to both solstices were observed at Byse, and it is possible that the extreme rising and setting points of the moon were also observed here. The site at Nilaskal seems to be a larger and more refined site of this kind. Judging from preliminary studies, the form and layout of the sites at Heragal, Mumbaru and the newly discovered site at Aaraga Gate, as well as the site at Nagbhid in Vidarbha, suggest that this typology was perhaps quite common. However, only by means of a thorough archaeological investigation of all the sites, including excavation of buried stumps of missing menhirs and the disturbed cairns among the menhirs and intact ones in the southern portion of the clearing at Byse and also Nilaskal and the other sites can help us in understanding whether this was a calendar device or just a “magical” alignment related to the cult of the dead at burial sites, of some importance to the builders of these monuments that is lost today in the mists of time.

There have been conjectures about astronomical purpose in the design of the alignments in north Karnataka (Rao 2005, Rao and Thakur 2010), however, the large number of boulders and lack of surveys in their study have made inferences inconclusive. This investigation has identified the first reliable instance of intentional astronomical alignments in an Indian megalith. Whatever the purpose of such intentional alignments, the findings are exciting because they point to the knowledge of astronomy among the builders, as embedded in the monuments they left behind. Especially the possibility that these ancient people may have had knowledge of the 18.6 year lunar cycle is very exciting, because it would have needed several generations of observations and transmission of information, which would indicate a sophisticated culture with language, and possibly script, or a highly refined oral tradition, to make this possible. Such information, if supplemented by evidence from more traditional lines of archaeological inquiry, can advance our understanding of our megalith-building ancestors many fold.

I cannot help ending this section with the following words: What drama of ritual pomp and pageantry must have been played out here, where the stones alone stand mute witnesses today..? We probably will never know…

Figure 6.25: What role did the Sun play in the cosmology of the builders of the megaliths at Nilaskal?

6.4 Perspectives for future research: Towards the conclusion of this investigation, a list was prepared of several questions for further research that turned up during the course of this study. Some of them concern a few of the sites studied for this investigation, while several others pertain to megaliths and megalithic culture in general. The most important of these will be elaborated below. Most of these are discussed in Menon (2012).

6.4.1 Inclinations of the stones at Nilaskal: It was observed that several of the menhirs at Nilaskal were inclined eastwards at very similar angles (Fig. 6.26). It is impossible to determine whether these inclinations are intentional or wrought by the passage of time since the erection of the menhirs. It will be required to excavate next to the menhirs to understand this. Also, though it appears certain that the menhirs were erected by prehistoric cultures, it is standard archaeological procedure to confirm that they are indeed the result of anthropogenic activities by sinking a test pit next to selected menhirs and verifying whether there is an underlying cultural deposit.

Figure 6.26: Showing a few of the prominent leaning stones at Nilaskal

6.4.2 Examination of the sepulchral megaliths at Byse: The menhirs at Byse are associated with cairns that are usually sepulchral (Fig. 6.24). Byse thus comes across as an archaeologically rich and complex site, with menhirs associated with burials. The southern portion of the site is virtually a cairn cemetery with several intact and disturbed cairns distributed in this area. It would be especially interesting to see whether the menhirs were erected by the same culture which created the cairns and whether the the erection of the menhirs disturbed any existing cairns in the area. If the menhirs are indeed marking burials, then their astronomical layout is even more intriguing as to what the import of the same was to the builders. This can be settled only by carrying out excavations at the site.

Also of great archaeological interest would be to examine whether the two mounds with Virakals in the south (Fig. 6.23) are indeed tombs that belonged to the Nayaka Dynasty as we have concluded from similarity in style to the Nayaka tombs near Devagange.

6.4.3 Identification of source quarries: It is certain that at least some of the quarried slabs at Byse came from the quarried area in the south (Fig. 6.27). However, the source for some of the elongated boulders used and the source quarried for Nilaskal are not certain. Exploratory assays in the nearby regions need to be carried out to identify the source of the stones.

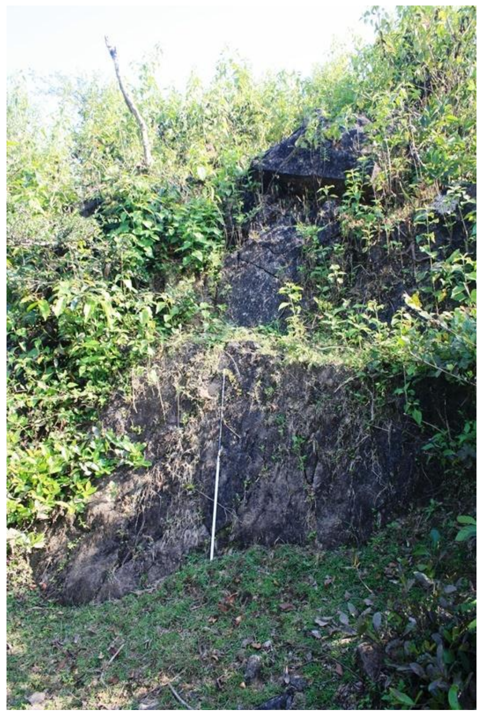


Figure 6.27: The quarried area in the south at Byse

6.4.4 Habitation sites for Nilaskal and Byse: The habitation sites associated with the cultures that erected the megaliths at both sites are not traced. The discovery of the habitation sites would be very important to develop a more complete understanding of these cultures.

6.4.5 Development of adequate statistical methods for testing ancient astronomical sites: It has been demonstrated earlier that conventional statistical methods for testing ancient astronomical sites may not be adequate to test every type of site possible. It is most imperative that adequate statistical methods for the testing of various types of astronomical sites be developed so that no site is passed by for having failed these inadequate tests. The number of

sites related to ancient astronomy that are well-preserved enough to permit study may in the first place be very limited and if these fail to be recognized, it would be a serious setback to the study of the origins of astronomy in this region and elsewhere.

6.4.6 Study of similar megalithic types in differing contexts: This study has proved that menhirs cannot be deemed to be non-sepulchral even within Karnataka, as was supposed earlier. It is quite possible that the menhir as a typology would have signified different meanings in different contexts – as marker for burial or as a memorial stone or marker for terrestrial or celestial reference. This could be true for other megalithic typologies such as the dolmen – for instance which have been seen in sepulchral as well as commemorative contexts. It might be prudent to undertake studies of the various megalithic types in different regions and contexts to understand the variations in their significance and purpose.

Similarly, it might be useful to study the significance of cupmarks found on megaliths or as associated with them in different contexts (Figs.5.9,6.28). It is quite possible again that cupmarks had different meanings in different contexts. Cupmarks and rock art are the only "text" that these pre-literate cultures have left behind for us to comprehend their knowledge-systems. A detailed study of these will certainly help us understand better the purpose of the contexts in which they are found.

Figure 6.28: A double-row of cupmarks excised in a boulder of a boulder circle at Junapani

6.4.7 The relationship of megaliths with later religious traditions and architecture: There is no doubt that the stone-working, design and construction skills that resulted from the production of megaliths would have contributed to the growth and progress of later architecture. The relationship of megaliths with later religious traditions like Buddhism and Jainism has often been debated, with some evidence even of deliberate Buddhist occupation of protohistoric graveyards (Schopen 2010). The association of megaliths with ancient Jain and Buddhist sites is quite frequently encountered. The form of the Buddhist stupa as a refined sepulchral megalith has often been suggested, just as the Jain tradition of large Bahubali statues equated with commemorative anthropomorphic figures. Discovery of megalithic cists within stupas – such as at Amaravati, have reinforced this. The dolmens of Hire Benakal, when intact, had coursed rubble packing around them to prevent the orthostats from collapsing outwards and inclined slabs of stone resting on these outside. There still are heaps of rubble to be found above the capstones of several dolmens at Hire Benakal, suggesting that the completed monument when intact resembled a large mound. Some of the more-or-less intact IPC's at Hire Benakal reinforces this line of thought (Fig. 6.29).

Figure 6.29: An almost intact IPC at Hire Benakal has the appearance of a mini-stupa

Kramrisch (1976) has suggested that some of the early flat-roofed Hindu temples had the origin of their form in the megalithic dolmen. The form and construction of some of the smaller shrines, like this example at Pattadakal seem to suggest this, too (Fig. 6.30).

Figure 6.30: One of the small shrines at Pattadakal is reminiscent of the dolmen in its execution

It is a well-known fact that during the initial centuries of the Christian era, when most of the religious architecture of the subcontinent was developing, megalithic practices were still continuing in many areas. The influence of these early structures on later architecture would make an interesting and useful study as we progress towards understanding the contributions of ancestors beyond the reaches of immediate cultural memory in shaping our own cultures.

Executive Summary:

Cosmic Considerations in Megalithic Architecture:
An investigation into possible astronomical intent in the design and layout of megalithic monuments of the Indian subcontinent with a view to understanding megalithic knowledge systems

This dissertation discusses the results of investigation of the megalithic structures of the Indian subcontinent for deliberate orientation to directions of astronomical significance. Megaliths are the earliest known examples of construction of monuments on the Indian subcontinent, generally ascribed to the south Indian Iron Age. It was only with the advent of agriculture in the Neolithic in south India (c. 3000BC) that early humans could start living a settled life as an agro-pastoralist. The earliest attempts at monumental architecture in the subcontinent are probably the enigmatic ashmounds of the south Indian Neolithic, though the exact nature and purpose of these structures remain shrouded in mystery. The construction of megaliths – which are a class of features, varied in form, made of locally available stone or sometimes, with earth, are much more widely distributed over the subcontinent than ashmounds, may have started as early as the middle period of the Neolithic, though it appears that their popularity peaked in the subsequent Iron Age (c. 1200BC – 500BC).

A large fraction of megalithic monuments were burials or memorials. However, there are several typologies, such as the megalith type known as stone alignment, which do not fit either description. Such structures typically have several large stones spread over an area of several hundred square meters.

The present work was undertaken to comprehend the understanding of space and knowledge-systems of the creators of these monuments based on the design and layout of these structures. We put special emphasis on the concept of space and astronomy in these megaliths.

In the Chapter 1, we summarise our current understanding of the stages of world prehistory and place the prehistory of the Indian subcontinent in this context. We describe the Age of the megaliths in a separate section to emphasise the cultural context of these monuments in the framework of our understanding of settlement patterns and socio-economic conditions prevailing during the period.

In Chapter 2, we describe the intellectual origins of astronomy in human evolution as understood from studies of prehistoric monuments all over the world and focus on the Indian context, as interpreted from early literary and archaeological sources. We discuss the possible astronomical phenomena – events and cycles that could have been observed and tracked by early man with the unaided eye and the social and technological context of these observations and measurement.

Chapter 3 looks at the design, form and structure of the Indian megaliths in detail and explores the possibilities of intentional orientation of some megalithic types to directions of astronomical significance. We also investigate the specific typologies that could have been designed specifically for astronomical observations. We explore the classification of Indian megaliths and the form of each typology studied in detail, with emphasis on the structural and architectural aspects. The issues of orientation, its measurement, and accuracy of alignments is also discussed. We specifically emphasize the possibilities that isolated menhirs may have been used as gnomons, or may have acted as markers for fore- and back-sights of astronomical sightlines. We also explore the complex megaliths such as stone alignment/avenue and address their relation to astronomy and the cosmos.

Subsequent to this, in Chapter 4, we emphasise the methodology adopted in this investigation to meet the objectives of the present study, which is to identify any intentional alignment or other characteristic in the design of megaliths which may be related to keep track of any astronomical phenomenon. This may include deliberate orientations to astronomical phenomena like sunrise/sunset on certain dates for specific ritual purposes such as mortuary ceremonies and even to mark time by observing the solar/lunar cycle. We follow a two-pronged approach wherein we survey and study orientations in a limited sample of various megalithic types and

study them for intentional orientations. We then compare them with theoretical expectations for alignments intended to study various astronomical phenomena of interest to the megalith-builders by deriving forms for structures that could have been used for astronomical studies. We then give a detailed description of all the study areas and their contexts. We also outline survey and other study methods in this part of the chapter.

Chapter 5 presents the data from the various megalithic sites – including details of the surveys, site features and monument descriptions, orientation and alignment data etc. We analyse the data from various sites and present the details on sites that seem to have astronomical relevance. We discuss the statistical tests used to derive the sightlines to determine whether the observed phenomena could occur due to random chance.

In Chapter 6, we present our major findings and discussion of their relevance in the context of state of knowledge in the field. The major findings of this investigation include the establishment of a new category of megalithic stone alignments detected in two regions geographically removed from each other and the identification of definite astronomical orientations (to the Solstices and possibly the Lunistices) of sightlines in stone alignments in at least two such sites. Minor findings include understanding patterns in orientation of sepulchral megaliths at various localities and the possible correspondence of the same with chronology as guessed from stylistic variations. Another consequence of this investigation is the discovery of two new megalithic sites in the course of our explorations. The monuments where intentional astronomical alignments were observed are compared to similar monuments elsewhere in the country and the world. We also discuss the possibility of using archaeoastronomy for the dating of such sites especially in the context of the poor understanding of the chronology of megalithic monuments in India. We also discuss the possibility of new findings based on these investigations to further understanding of later architecture and astronomy in the region.

In conclusion, we present the new findings from this research and emphasise its relevance to the status of knowledge in the study of megalithic architecture and ancient astronomy in the Indian subcontinent. The directions for future research springing from the current investigation are also outlined – especially with regard to understanding later monumental architecture in the subcontinent – be they sepulchral/memorial stupas, anthropomorphic figures or open-air/structural temples. The architectural and sculptural wealth of this region is exceedingly rich and megalithic structures arguably represent the earliest steps in the development of the human attempts to delineate and use space exclusively for motives that go beyond the mere functional and more of expressions of belief-systems of the builders – be they burial or astronomy. The knowledge of heavenly phenomena and cycles and the influence of these on the design and layout of early terrestrial monumental structures is an essential starting point in our understanding of the concepts behind the development of the form and principles of later architecture, especially of religious and monumental nature in this region.

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References

1. Renfrew, C., Prehistory: The Making of the Human Mind (2007) Phoenix, London.
2. Kennedy, K. A. R., God-Apes and Fossil Men: Palaeoanthropology in South Asia (2000) The University of Mishigan Press, Ann Arbor.
3. Rao, M. S. N., Progress of Archaeology in Karnataka:1956-1972 (1978) Directorate of Archaeology and Museums in Karnataka, Mysore.
4. Habib, I., Prehistory (2001) Aligarh Historians Society, Aligarh.
5. Leakey, R., The Origin of Humankind (1994) Orion Books Ltd., London.
6. Mithen, S., The Prehistory of the Mind: A Search for the Origins of Art, Religion and Science (1996) Thames and Hudson, London.
7. Lewis-Williams, D., The Mind in the Cave: Consciousness and the Origin of Art (2002) Thames and Hudson, London.
8. Thapar, R., The Penguin History of Early India: From the Origins to AD 1300 (2002) Penguin Books, New Delhi.
9. Wilson, P., The Domestication of the Human Species (1988) Yale University Press, New Haven, Conn.
10. Sheratt, A., The genesis of megaliths: monumentality, ethnicity and social complexity in Neolithic north-west Europe (1990) World Archaeology, 22, 2.
11. Hoskin, M., Tombs, Temples and their Orientations (2001) Ocarina Books, Sussex.
12. Ruggles, C., Astronomy in Prehistoric Britain and Ireland (1999), Yale University Press, New Haven and London.
13. Moorti, U. S., Megaliths, in Pearsall, D. M. (ed.), Encyclopedia of Archaeology (2008), Academic Press, New York.
14. Sharma, A. K., Early Man in Jammu Kashmir and Ladakh (2000) Agam Kala Prakashan, Delhi.
15. Castleden, R., The Stonehenge People: An Exploration of Life in Neolithic Britain 4700-2000 BC (1987), Routledge and Kegan Paul, London.
16. Atkinson, R. J. C., Stonehenge (1956) Penguin Books, England.
17. Hoyle, F., On Stonehenge (1977) W. H. Freeman and Co., San Francisco.
18. Sundara, A., The early chamber tombs of South India: a study of the Iron Age megalithic monuments of N. Karnataka (1975) University Publishers, Delhi.

19. Moorti, U. S., Megalithic Culture of South India: Socio-Economic Perspectives (1994) Ganga Kaveri Publishing House, Varanasi.
20. Chippindale, C., Stonehenge Complete (2004) Thames and Hudson, London.
21. Heggie, D. C., Megalithic Science: Ancient Mathematics and Astronomy in Northwest Europe (1981) Thames and Hudson Ltd., London.
22. Joshi J. P. et al, Inventory of Monuments and Sites of National Importance, Vol. VII, Part 3 (2006) Archaeological Survey of India, New Delhi.
23. Chakrabarti, D. K., India: an Archaeological History (Palaeolithic Beginnings to Early Historic Foundations) (1999) Oxford University Press, New Delhi.
24. Ehrich, R. W. (Ed.), Chronologies in Old World Archaeology Vol. I (1992) The University of Chicago Press, Chicago and London.
25. Possehl, G. L., The Indus Civilization: a Contemporary Perspective (2002) Vistaar Publications, New Delhi.
26. Ratnagar, S., Understanding Harappa: Civilization in the Greater Indus Valley (2001) Tulika Books, New Delhi.
27. Allchin, B. and Allchin, R., The Rise of Civilization in India and Pakistan (1996) Cambridge University Press, New Delhi.
28. Morrison, K. D., Brahmagiri Revisited: A Re-Analysis of the South Indian Sequence, in South Asian Archaeology, 2001, in 1–10 ed. C. Jarrige and V. LeFevre (2005) Editions Recherche sur les Civilisations, Paris: ADPF.
29. Bauer, A. M., Johansen, P. and Bauer, R. L., Towards a Political Ecology in Early South India: Preliminary Considerations of the Sociopolitics of Land and Animal Use in the Southern Deccan, Neolithic through Early Historic Periods, Asian Perspectives, Volume 46, Number 1, Spring 2007, pp. 3-35.
30. Johansen, P. G. Landscape, Monumental Architecture and Ritual: A Reconsideration of the South Indian Ashmounds, Journal of Anthropological Archaeology 23 (2004) 309-330.
31. Boivin, N., Fuller, D., Korisettar, R. and Petraglia, M., First Farmers in South India: The Role of Internal Processes and External Influences in the Emergence and Transformation of South India's Earliest Settled Societies, Pragdhara, **18**, May 2008, 179-199.

32. Paddayya, K., The Ashmounds of South India: Fresh Evidence and Possible Explanation, Bulletin of the Deccan College Postgraduate Research Institute (1991) Deccan College, Pune.
33. Osborne, K. (Ed.) Stonehenge and Neighbouring Monuments, (1995) English Heritage, London.
34. Brubaker, R., Aspects of Mortuary Variability in the South Indian Iron Age, Bulletin of the Deccan College Postgraduate Research Institute, 60-61 (2001) Deccan College, Pune, 253-302.
35. Meadows-Taylor, Col., Megalithic Tombs and other Ancient Remains in the Deccan (1941) The Archaeological Department of Hyderabad, Hyderabad.
36. Babington. J., Descriptions of the Pandoo Coolies of Malabar, Transactions of the Literary Society of Bombay (1823) Vol. III, 324-330.
37. Krishna, M. H., ARMAD (1942), 100-109.
38. Ghosh, A. (Ed), An encyclopaedia of Indian Archaeology (1989) **II**, Munshiram Manoharlal Pub. Pvt. Ltd. New Delhi.
39. Wheeler, R. E. M., Brahmagiri and Chandravalli 1947: Megalithic and Other Cultures in the Chitaldrug District, Mysore State, Ancient India, **IV**, (1948) 81-308.
40. Agrawal, R. C., The Megalithic Culture of India: its Genesis, Spread and Continuity, Keynote address.
41. Rajan, K., Archaeology of the South Arcot Region with Special Reference to Megalithic Burial Complexes, Man and Environment XXIII (1) (1998) 93-105.
42. Rajan K., Athiyaman, N., Rajesh, M. and Saranya M., Excavations at Thandikudi, Tamil Nadu, Man and Environment XXX (2) (2005) 49-65.
43. Anglade, A. and Newton, L. V., The Dolmens of the Pulney Hills, Memoirs of the Archaeological Survey of India, No. 36 (1928) Central Publication Division, Govt. of India, Calcutta.
44. Allchin, F. R., The Stone Alignments of Southern Hyderabad, Man, Vol. 56 (Oct. 1956) 133-136.
45. Paddayya, K., The Stone Alignment at Hanamsagar, District Gulbarga, Karnataka, In Srinivasan, L. K. and Nagaraju, S., Eds., Sri Nagabhinandanam, (1995) Dr. M. S. Nagaraja Rao felicitation committee, Bangalore, 23.

46. Thapar, B. K., Maski 1954: A Chalcolithic Site of the Southern Deccan, Ancient India, Number 13 (1957) 4-142.
47. Mathpal, Y., Rock Art in Kerala (1998) Aryan Books International, New Delhi.
48. Mohanty, R. K., Some Important Observations: Excavations at Mahurjhari (2001-2004), Man and Environment, XXX (1) (2005) 106-107.
49. Leshnik, L. S., Pastoral Nomadism in the Archaeology of India and Pakistan, World Archaeology, Vol. 4, No. 2, (Oct. 1972) 150-166.
50. Dey, S. K., Black and Red Ware: a Metrical Analysis of Two Different Cultures (Chalcolithic Culture and Megalithic Culture of India), Anthropologist, **5** (2) (2003), 131-136.
51. Mudhol, M. S., A Technical Study of Megalithic Metal Objects (1997) Directorate of Archaelogy and Museums, Mysore.
52. Selvakumar, V., Cognitive Aspects of the Iron Age-Early Historic ("Megalithic") Cultures of South India, National Seminar on Indian Megaliths – Archaeological and Ethnographic Sources (2005) Indira Gandhi Rashtra Manava Sangrahalaya.
53. Schopen, G., Immigrant Monks and the Protohistorical Dead: The Buddhist Occupation of Early Burial Sites in India, in Indian Monastic Buddhism: Collected Papers on Textual, Inscriptional and Archaeological Evidence (2010) Motilal Banarsidass Publishers Private Limited, Delhi, Part II, pp 360-81.
54. Kramrisch, S., The Hindu Temple (1976) Motilal Banarsidass Publishers Pvt. Ltd., Delhi.
55. Krupp, E. C., In Search of Ancient Astronomies (1977) Doubleday, New York.
56. Krupp, E. C., Echoes of Ancient Skies: The Astronomy of Lost Civilisations (1983) John Wiley and Sons, New York.
57. Hadingham, E., Early Man and the Cosmos (1983) William Heinemann, Ltd. London.
58. Armstrong, G., A Short History of Myth (2005) Penguin Books, New Delhi.
59. Baity E., Archaeoastronomy and Ethnoastronomy, CurrentAnthropology, (1973) Vol. 14, No 4, 389 – 449.
60. Norris, R. P., Megalithic Observatories in Britain: Real or Imagined? In Proc. ASA (1984) **5** (4) 428-434.
61. Ridpath, I., Norton's Star Atlas and Reference Handbook (Epoch 2000.0) (1998) Addison Wesley Longman Ltd. England.

62. Smart, W. M., Textbook on Spherical Astronomy (1977) Cambridge University Press, Cambridge.
63. Hoskin, M. (ed.), The Cambridge Illustrated History of Astronomy (1997) Cambridge University Press, Cambridge.
64. Narlikar, J. V., The Scientific Edge: The Indian Scientist from Vedic to Modern Times (2003) Penguin Books, New Delhi.
65. Vahia, M. N., Menon, S. M., Abbas, R. and Yadav, N., Megaliths in Ancient India and Their Possible Association with Astronomy, In Nakamura, T., Orchiston, W., Sôma, M., and Strom, R. (eds.) (2011) Mapping the Oriental Sky. Proceedings of the Seventh International Conference on Oriental Astronomy. Tokyo, National Astronomical Observatory of Japan. Pp. 13-20.
66. Burgess. E. (tr.), Gangooly, P. (ed.), The Surya Siddhanta: A Text-book of Hindu Astronomy (1860) Motilal Banarsidass Publishers Pvt. Ltd., Delhi.
67. Thom, A., Megalithic Sites in Britain (1967) Oxford University Press, Oxford.
68. Hawkins, G. S., Stonehenge Decoded, Nature (1963) Vol. 200, pp 306.
69. Hawkins, G. S., Stonehenge: A Neolithic Computer, Nature (1964) Vol. 202, pp 1258.
70. Hawkins, G. S., Stonehenge Decoded (1965) Doubleday, New York.
71. Hawkins, G. S., Astro-Archaeology (1966) Report of Smithsonian Astrophysical Observatory, Boston University.
72. Hoyle, F., On Stonehenge (1977) W. H. Freeman and Co., San Francisco.
73. Thom, A., Thom, A. S. and Thom, A. S., Stonehenge, Journal for the History of Astronomy, v (1974) pp 71-90.
74. Thom, A., Thom, A. S. and Thom, A. S., Stonehenge as a Possible Lunar Observatory, Journal for the History of Astronomy, vi (1975) pp 19-30.
75. Rao, N. K., Aspects of Prehistoric Astronomy in India, Bull. Astr. Soc. India (2005) **33**, 499-511.
76. Rao, N. K., Astronomical Orientations of the Megalithic Stone Circles of Brahmagiri, Bull. Astr. Soc. India (1993) **21**, 67-77.
77. Vahia, M. N. and Menon, S. M., A Possible Astronomical Observatory at Dholavira, submitted (2012) Man and Environment.

78. Bisht, R. S., Dholavira and Banawali: Two Different Paradigms of the Harappan Urbis Forma, Puratattva (1999) 29: 14-37.

79. Bisht, R. S., Urban Planning at Dholavira: A Harappan City, In Malville, J. M. and Gujral, L. M. (ed.), Ancient Cities, Sacred Skies: Cosmic Geometries and City Planning in Ancient India (2000) Aryan Books International, New Delhi.

80. Menon, S. M. and Vahia, M. N., Investigating Megalithic Astronomy: the role of remote sensing, In Forte, M., Campana, S. and Liuzza, C. (Ed.), Proceedings of the Space, Time, Place: third International Conference on remote sensing in archaeology (2010), Archaeopress (BAR International Series 2118), Oxford, 333-337.

81. Menon, S. M., Vahia, M. N. and Rao, K., Megalithic Astronomy in the Indian Subcontinent, Submitted (September 2010a, chapter in book on megaliths being prepared by Deccan College, Pune).

82. Menon, S. M. and Vahia, M. N., Megalithic Astronomy in South India, In Nakamura, T., Orchiston, W., Sôma, M., and Strom, R. (eds.) (2011) Mapping the Oriental Sky. Proceedings of the Seventh International Conference on Oriental Astronomy. Tokyo, National Astronomical Observatory of Japan. Pp. 21-26.

83. Menon, S. M., Vahia, M. N. and Rao, K., New Discoveries of Stone Alignment and Megalithic Burials in Karnataka, Karnataka, Man and Environment (2011) XXXVI (1) 92-95.

84. Menon, S. M., Vahia, M. N. and Rao, K., Stone Alignment with Solar and Other Sightlines in South India, Current Science, Vol. 102, No. 5 (10 March 2012a) Pp. 683-684.

85. Menon, S. M., Vahia, M. N. and Rao, K., Stone Alignments with Solar and Lunar Sightlines in India, Submitted (2012b) Man and Environment.

86. Devaraj, D. V., Joshi, N. V., Patil and Gangadhara, T. S., Heggadehalli – A Report on Megalithic Excavations: 1995 (1996) Directorate of Archaeology and Museums, Mysore.

87. Salt, A. M., The Astronomical Orientation of Ancient Greek Temples, PLoS One (November 2009) **4**, 11.

88. Ray, H. P., The Changing Landscape: Emergence of the Hindu Temple in the Deccan, Manuscript, in preparation.

89. Baity E., Archaeoastronomy and Ethnoastronomy, CurrentAnthropology, (1973) Vol. 14, No 4, 389 – 449.

90. Cooke, J. A., Few, R. W., Morgan J. G. and Ruggles, C. L. N. Indicated Declinations at the Callanish Megalithic Sites, Journal of History of Astronomy (1977) vii, 113-133.

91. Kelley, D. H. and Milone, E. F., Exploring Ancient Skies: an Encyclopedic Survey of Archaeoastronomy (2005) Springer, USA.

92. Thapar, B. K., Maski 1954: A Chalcolithic Site of the Southern Deccan, Ancient India, Number 13 (1957) 4-142.

93. Norris, R. P. and Hamacher, D. W., Astronomical Symbolism in Australian Aboriginal Rock Art, Rock Art Research (May 2011) Vol. 28, No. 1, AURA Australia.

94. Sundara, A., Some Aspects of the Neolithic Sites in Malnad, Mysore State (1969) In Quarterly Journal of Mythic Society, Bangalore **LIX** pp1-4.

95. Sundara, A., Menhirs in Mid-western Karnataka: Further Notices, In Sundara A., Ed., Proceedings of R. B. Foote Memorial National Seminar (1995) on Indian Prehistory and Protohistory (Recent Studies) (2004) Directorate of Archaeology and Museums, Govt. of Karnataka.

96. Rao, B. K. G., The Megalithic Culture in South India (1972) Prasaranga, University of Mysore, Mysore.

97. Satyamurthy, T., The Iron Age in Kerala: a report on Mangadu excavation (1992) Department of Archaeology, Kerala.

98. Suvrathan, U., Landscapes of Life and Death: Considering the Region of Vidarbha, In Singh, U. and Lahiri, N., Ed., Ancient India: New Research (2010) Oxford University Press, New Delhi.

99. Aveni, A. F., Archaeoastronomy, in Advances in Archaeological Method and Theory (1981) Vol. 4, 1-77.

100. Allchin, F. R., Archaeological Sites in the Benkal Forest, Hyderabad, Man, Vol. 60 (1955) 97-99.

101. Thapar, B. K., In A. Ghosh (Ed), Indian Archaeological Review 1961-62 (1961) p 32.

102. Wheatley, M and Taylor, B., Avebury: Sun, Moon and Earth, Undated, Wessex Books.

Bibliography

a. Megaliths

1. Agrawal, R. C., The Megalithic Culture of India: its Genesis, Spread and Continuity, Keynote address.
2. Allchin, F. R., Archaeological Sites in the Benkal Forest, Hyderabad, Man, Vol. 60 (1955) 97-99.
3. Allchin, B. and Allchin, R., The Rise of Civilization in India and Pakistan (1996) Cambridge University Press, New Delhi.
4. Allchin, F. R., The Stone Alignments of Southern Hyderabad, Man, Vol. 56 (Oct. 1956) 133-136.
5. Anglade, A. and Newton, L. V., The Dolmens of the Pulney Hills, Memoirs of the Archaeological Survey of India, No. 36 (1928) Central Publication Division, Govt. of India, Calcutta.
6. Babington. J., Descriptions of the Pandoo Coolies of Malabar, Transactions of the Literary Society of Bombay (1823) Vol. III, 324-330.
7. Bahn, P. G., Prehistoric Rock Art: polemics and progress (2010) Cambridge University Press, Cambridge.
8. Brown, P. L., Megaliths, Myths and Men: an introduction to astro-archaeology (1976) Dover Publications, Inc. New York.
9. Brubaker, R., Aspects of Mortuary Variability in the South Indian Iron Age, Bulletin of the Deccan College Postgraduate Research Institute, 60-61 (2001) Deccan College, Pune, 253-302.
10. Chakrabarti, D. K., India: an Archaeological History (Palaeolithic Beginnings to Early Historic Foundations) (1999) Oxford University Press, New Delhi.
11. Devaraj, D. V., Joshi, N. V., Patil and Gangadhara, T. S., Heggadehalli – A Report on Megalithic Excavations: 1995 (1996) Directorate of Archaeology and Museums, Mysore.

12. Dey, S. K., Black and Red Ware: a Metrical Analysis of Two Different Cultures (Chalcolithic Culture and Megalithic Culture of India), Anthropologist, **5** (2) (2003), 131-136.
13. Ehrich, R. W. (Ed.), Chronologies in Old World Archaeology Vol. I (1992) The University of Chicago Press, Chicago and London.
14. Ghosh, A. (Ed), An encyclopaedia of Indian Archaeology (1989) **II**, Munshiram Manoharlal Pub. Pvt. Ltd. New Delhi.
15. Jayashree, K. N., Exploring the Megaliths in Kasaragod, The Journal of the Centre for Heritage Studies, Vol. 2 (2005), 18-35.
16. Joshi J. P. et al, Inventory of Monuments and Sites of National Importance, Vol. VII, Part 3 (2006) Archaeological Survey of India, New Delhi.
17. Joshi, R. V., Prehistory and Protohistory of India (Recent Trends and Prospects), In Sundara A., Ed., Proceedings of R. B. Foote Memorial National Seminar (1995) on Indian Prehistory and Protohistory (Recent Studies) (2004) Directorate of Archaeology and Museums, Govt. of Karnataka.
18. Kramrisch, S., The Hindu Temple (1976) Motilal Banarsidass Publishers Pvt. Ltd., Delhi.
19. Krishna, M. H., ARMAD (1942), 100-109.
20. Leshnik, L. S., Pastoral Nomadism in the Archaeology of India and Pakistan, World Archaeology, Vol. 4, No. 2, (Oct. 1972) 150-166.
21. Lorblanchet, M., Rock Art in the Old World (1992) Aryan Books International, New Delhi.
22. Mathpal, Y., Rock Art in Kerala (1998) Aryan Books International, New Delhi.
23. Meadows-Taylor, Col., Megalithic Tombs and other Ancient Remains in the Deccan (1941) The Archaeological Department of Hyderabad, Hyderabad.
24. Menon, S. M., Vahia, M. N. and Rao, K., New Discoveries of Stone Alignment and Megalithic Burials in Karnataka, Karnataka, Man and Environment (2011) XXXVI (1) 92-95.
25. Menon, S. M. Ancient Stone Riddles; megaliths of the Indian Subcontinent (2012) Manipal University Press, Manipal.
26. Mohanty, R. K., Some Important Observations: Excavations at Mahurjhari (2001-2004), Man and Environment, XXX (1) (2005) 106-107.

27. Moorti, U. S., Megalithic Culture of South India: Socio-Economic Perspectives (1994) Ganga Kaveri Publishing House, Varanasi.
28. Moorti, U. S., Megaliths, in Pearsall, D. M. (ed.), Encyclopedia of Archaeology (2008), Academic Press, New York.
29. Morrison, K. D., Brahmagiri Revisited: A Re-Analysis of the South Indian Sequence, in South Asian Archaeology, 2001, in 1–10 ed. C. Jarrige and V. LeFevre (2005) Editions Recherche sur les Civilisations, Paris: ADPF.
30. Mudhol, M. S., A Technical Study of Megalithic Metal Objects (1997) Directorate of Archaelogy and Museums, Mysore.
31. Paddayya, K., The Stone Alignment at Hanamsagar, District Gulbarga, Karnataka, In Srinivasan, L. K. and Nagaraju, S., Eds., Sri Nagabhinandanam, (1995) Dr. M. S. Nagaraja Rao felicitation committee, Bangalore, 23.
32. Rajan, K., Archaeology of the South Arcot Region with Special Reference to Megalithic Burial Complexes, Man and Environment XXIII (1) (1998) 93-105.
33. Rajan K., Athiyaman, N., Rajesh, M. and Saranya M., Excavations at Thandikudi, Tamil Nadu, Man and Environment XXX (2) (2005) 49-65.
34. Rajendran, P., Oliyani Cist Burial Excavation, Kottayam District, Kerala, The Journal of the Centre for Heritage Studies, Vol. 2 (2005), 41-46.
35. Rao, B. K. G., The Megalithic Culture in South India (1972) Prasaranga, University of Mysore, Mysore.
36. Rao, M. S. N., Progress of Archaeology in Karnataka:1956-1972 (1978) Directorate of Archaeology and Museums in Karnataka, Mysore.
37. Ray, H. P., The Changing Landscape: Emergence of the Hindu Temple in the Deccan, Manuscript, in preparation.
38. Rea, A., Catalogue of the Prehistoric Antiquities from Adichanallur and Perumbair (1915) The Principal Commissioner of Museums, Government Museum, Chennai.
39. Satyamurthy, T., The Iron Age in Kerala: a report on Mangadu excavation (1992) Department of Archaeology, Kerala.
40. Schopen, G., Immigrant Monks and the Protohistorical Dead: The Buddhist Occupation of Early Burial Sites in India, in Indian Monastic Buddhism: Collected Papers on

Textual, Inscriptional and Archaeological Evidence (2010) Motilal Banarsidass Publishers Private Limited, Delhi, Part II, pp. 360-81.

41. Selvakumar, V., Cognitive Aspects of the Iron Age-Early Historic ("Megalithic") Cultures of South India, National Seminar on Indian Megaliths – Archaeological and Ethnographic Sources (2005) Indira Gandhi Rashtra Manava Sangrahalaya.
42. Sharma, A. K., Early Man in Jammu Kashmir and Ladakh (2000) Agam Kala Prakashan, Delhi.
43. Sheratt, A., The genesis of megaliths: monumentality, ethnicity and social complexity in Neolithic north-west Europe (1990) World Archaeology, **22**, 2.
44. Shetty, V., Some Recent Archaeological Notices: Megalithic Relics in Dakshina Kannada – A Study, in Sundara, A. (Ed.), Archaeology in Karnataka (Papers presented at the National Seminar on Archaeology, 1985) (1990) Directorate of Archaeology and Museums, Mysore, 215-218.
45. Subbayya, K. K., New Light on the Megalithic Excavations at Heggadehalli and Koppa, in Sundara, A. (Ed.), Archaeology in Karnataka (Papers presented at the National Seminar on Archaeology, 1985) (1990) Directorate of Archaeology and Museums, Mysore, 151-153.
46. Sundara, A., Some Aspects of the Neolithic Sites in Malnad, Mysore State (1969) In Quarterly Journal of Mythic Society, Bangalore **LIX** pp1-4.
47. Sundara, A., The early chamber tombs of South India: a study of the Iron Age megalithic monuments of N. Karnataka (1975) University Publishers, Delhi.
48. Sundara, A., Menhirs in Mid-western Karnataka: Further Notices, In Sundara A., Ed., Proceedings of R. B. Foote Memorial National Seminar (1995) on Indian Prehistory and Protohistory (Recent Studies) (2004) Directorate of Archaeology and Museums, Govt. of Karnataka.
49. Suvrathan, U., Landscapes of Life and Death: Considering the Region of Vidarbha, In Singh, U. and Lahiri, N., Ed., Ancient India: New Research (2010) Oxford University Press, New Delhi.
50. Thapar, B. K., Maski 1954: A Chalcolithic Site of the Southern Deccan, Ancient India, Number 13 (1957) 4-142.
51. Thapar, B. K., In A. Ghosh (Ed), Indian Archaeological Review 1961-62 (1961) p 32.

52. Visvanathan, M., Of Death and Fertility: Landscapes of Heroism in Ancient South India, In Singh, U. and Lahiri, N., Ed., Ancient India: New Research (2010) Oxford University Press, New Delhi.
53. Wheatley, M and Taylor, B., Avebury: Sun, Moon and Earth, Undated, Wessex Books.
54. Wheeler, R. E. M., Brahmagiri and Chandravalli 1947: Megalithic and Other Cultures in the Chitaldrug District, Mysore State, Ancient India, **IV**, (1948) 81-308.

b. Stonehenge

55. Andersen, S. E. and Fletcher, E. S., The Inverse Stonehenge Problem, Current Anthropology, Vol. 9, No. 4 (Oct. 1968) pp 316-318.
56. Atkinson, R. J. C., The Stonehenge Stations, Journal for the History of Astronomy vii (1976) pp142-144.
57. Atkinson, R. J. C., Stonehenge (1956) Penguin Books, England.
58. Castleden, R., The Stonehenge People: An Exploration of Life in Neolithic Britain 4700-2000 BC (1987), Routledge and Kegan Paul, London.
59. Chippindale, C., Stonehenge Complete (2004) Thames and Hudson, London.
60. Dibble, W. E., A Possible Pythagorean Triangle at Stonehenge, Journal for the History of Astronomy vii (1976) pp 141-142.
61. Eddy, J. A., Popular Astro-Archaeology, Journal for the History of Astronomy (1974) pp 66.
62. Hawkins, G. S., Stonehenge Decoded, Nature (1963) Vol. 200, pp 306.
63. Hawkins, G. S., Stonehenge: A Neolithic Computer, Nature (1964) Vol. 202, pp 1258.
64. Hawkins, G. S., Stonehenge Decoded (1965) Doubleday, New York.
65. Hawkins, G. S., Astro-Archaeology (1966) Report of Smithsonian Astrophysical Observatory, Boston University.
66. Hoyle, F., On Stonehenge (1977) W. H. Freeman and Co., San Francisco.
67. Kirk, T. H., The Significance of the 56 Holes of the Aubrey Circle at Stonehenge, Quarterly Journal of the Royal Astronomical Society (1993) **34**, pp 567-568.
68. Kirk, T. H., A New Look at Stonehenge, The Observatory, Vol. 120 (2000) pp 308-313.

69. Osborne, K. (Ed.) Stonehenge and Neighbouring Monuments, (1995) English Heritage, London.
70. Potyomkina, T. M., The Trans-Ural "Stonehenge" (The Stone Age Sanctuary with Astronomic Reference Point) Astronomical and Astrophysical Transactions, Vol. 15 (1998) pp 307-324.
71. Robinson, J. H., Evidence Concerning Stonehenge as an "Observatory", Proceedings of the 164th AAS meeting (1984), Baltimore, pp 449.
72. Robinson, J. H., A Credible Pair of "Moonswing" Alignments at Stonehenge, Proceedings of the 173rd AAS meeting (1988), Boston, pp 951.
73. Sims, L., Lighting up Dark Moon: Ethnographic Templates for testing Paired Alignments on the Sun and the Moon, in Zedda M. P. and Belmonte, J. A. (ed.), Lights and Shadows in Cultural Astronomy (2007) Associazone Archeofila Sarda, Sardinia, pp 309-318.
74. Thom, A., Thom, A. S. and Thom, A. S., Stonehenge, Journal for the History of Astronomy, v (1974) pp 71-90.
75. Thom, A., Thom, A. S. and Thom, A. S., Stonehenge as a Possible Lunar Observatory, Journal for the History of Astronomy, vi (1975) pp 19-30.
76. White, W. H., Stone Circles and Stonehenge, The Journal of the Royal Astronomical Society of Canada, Vol. XLI, No. 1 (1947) pp 1-17.
77. Williams-Thorpe, O. et al, Preseli Dolerite Bluestones: Axe-Heads, Stonehenge Monoliths and Outcrop Sources, Oxford Journal of Archaeology 25 (1) (2006) pp 29-46.

c. Archaeoastronomy and History of Astronomy

78. Aveni, A. F., Archaeoastronomy, in Advances in Archaeological Method and Theory (1981) Vol. 4, 1-77.
79. Baity E., Archaeoastronomy and Ethnoastronomy, CurrentAnthropology, (1973) Vol. 14, No 4, 389 – 449.

80. Belmonte, J. A., Astronomy: Science or Culture? Fact and Fiction, in Ortiz-Gil and Martinez, V. (eds), Teaching and Communicating Astronomy – JENAM ’04 (2005), 16**,** 3-28.

81. Cooke, J. A., Few, R. W., Morgan J. G. and Ruggles, C. L. N. Indicated Declinations at the Callanish Megalithic Sites, Journal of History of Astronomy (1977) vii, 113-133.

82. Ghezzi, I. and Ruggles, C., Chankillo: A 2300-Year-Old Solar Observatory in Coastal Peru, Science (2007) Vol. 315.

83. Hadingham, E., Early Man and the Cosmos (1983) William Heinemann, Ltd. London.

84. Heggie, D. C., Megalithic Science: Ancient Mathematics and Astronomy in Northwest Europe (1981) Thames and Hudson Ltd., London.

85. Hoskin, M. (ed.), The Cambridge Illustrated History of Astronomy (1997) Cambridge University Press, Cambridge.

86. Hoskin, M., Tombs, Temples and their Orientations (2001) Ocarina Books, Sussex.

87. Kelley, D. H. and Milone, E. F., Exploring Ancient Skies: an Encyclopedic Survey of Archaeoastronomy (2005) Springer, USA.

88. Krupp, E. C., In Search of Ancient Astronomies (1977) Doubleday, New York.

89. Krupp, E. C., Skywatchers, Shamans and Kings (1997) John Wiley and Sons, New York.

90. Krupp, E. C., Echoes of Ancient Skies: The Astronomy of Lost Civilisations (1983) John Wiley and Sons, New York.

91. Malville, J. M., Cosmic Landscape and Urban Layout, in Fritz, J. M. and Michell, G. (ed.), New Light on Hampi (2001) Marg Publications, Mumbai.

92. Menon, S. M. and Vahia, M. N., Investigating Megalithic Astrronomy: the role of remote sensing, In Forte, M., Campana, S. and Liuzza, C. (Ed.), Proceedings of the Space, Time, Place: third International Conference on remote sensing in archaeology (2010), Archaeopress (BAR International Series 2118), Oxford, 333-337.

93. Menon, S. M., Vahia, M. N. and Rao, K., Megalithic Astronomy in the Indian Subcontinent, Submitted (September 2010, chapter in book on megaliths being prepared by Deccan College, Pune).

94. Menon, S. M. and Vahia, M. N., Megalithic Astronomy in South India, In Nakamura, T., Orchiston, W., Sôma, M., and Strom, R. (eds.) (2011) Mapping the Oriental Sky.

Proceedings of the Seventh International Conference on Oriental Astronomy. Tokyo, National Astronomical Observatory of Japan. Pp. 21-26.

95. Menon, S. M., Vahia, M. N. and Rao, K., Stone Alignment with Solar and Other Sightlines in South India, Current Science, Vol. 102, No. 5 (10 March 2012a) Pp. 683-684.
96. Menon, S. M., Vahia, M. N. and Rao, K., Stone Alignments with Solar and Lunar Sightlines in India, Submitted (2012b) Man and Environment.
97. Narlikar, J. V., The Scientific Edge: The Indian Scientist from Vedic to Modern Times (2003) Penguin Books, New Delhi.
98. Norris, R. P., Megalithic Observatories in Britain: Real or Imagined? In Proc. ASA (1984) **5** (4) 428-434.
99. Norris, R. P. and Hamacher, D. W., Astronomical Symbolism in Australian Aboriginal Rock Art, Rock Art Research (May 2011) Vol. 28, No. 1, AURA Australia.
100. Rao, N. K., Astronomical Orientations of the Megalithic Stone Circles of Brahmagiri, Bull. Astr. Soc. India (1993) **21**, 67-77.
101. Rao, N. K., Aspects of Prehistoric Astronomy in India, Bull. Astr. Soc. India (2005) **33**, 499-511.
102. Rao, N. K. and Thakur, P., The Astronomical Significance of Megalithic Stone Alignments at Vibhutihalli in Northern Karnataka, Journal of Astronomical History and Heritage (2010) 13(1), 74-82.
103. Ruggles, C., Astronomy in Prehistoric Britain and Ireland (1999), Yale University Press, New Haven and London.
104. Salt, A. M., The Astronomical Orientation of Ancient Greek Temples, PLoS One (November 2009) **4**, 11.
105. Smith, M. E., Did the Maya build Architectural Cosmograms?, Latin Amerucan Antiquity, (2005)16 (2) pp 217-224.
106. Thom, A., Megalithic Sites in Britain (1967) Oxford University Press, Oxford.
107. Vahia, M. N. and Menon, S. M., A Possible Astronomical Observatory at Dholavira, submitted (2012) Man and Environment.
108. Vahia, M. N., Menon, S. M., Abbas, R. and Yadav, N., Megaliths in Ancient India and Their Possible Association with Astronomy, In Nakamura, T., Orchiston, W., Sôma,

M., and Strom, R. (eds.) (2011) Mapping the Oriental Sky. Proceedings of the Seventh International Conference on Oriental Astronomy. Tokyo, National Astronomical Observatory of Japan. Pp. 13-20.

109. Volwahsen, A., Cosmic Architecture in India (2001) Mapin Publishing, Ahmedabad pp 15-18.

110. Wheeler, R. E. M., 1948, Ancient India, **IV**, 181-308.

111. Zedda M. P. and Belmonte, J. A. (ed.), Lights and Shadows in Cultural Astronomy (2007) Associazone Archeofila Sarda, Sardinia.

d. General and Archaeology

112. Archaeological Survey of India, Archaeological Remains: Monuments and Museums (Parts I & II) (1996) The Director General, ASI, New Delhi.

113. Armstrong, G., A Short History of Myth (2005) Penguin Books, New Delhi.

114. Austin, S., Themes in the Architecture of the Cave, made (2005) 2 2005.

115. Barrett, J. C., Defining Domestic Space in the Bronze Age of Southern Britain, in Pearson, M. P. and Richards, C. (ed.), Architecture and Order: Approaches to Social Space (1994) Routledge, London.

116. Bauer, A. M., Johansen, P. and Bauer, R. L., Towards a Political Ecology in Early South India: Preliminary Considerations of the Sociopolitics of Land and Animal Use in the Southern Deccan, Neolithic through Early Historic Periods, Asian Perspectives, Volume 46, Number 1, Spring 2007, pp. 3-35.

117. Bisht, R. S., Dholavira and Banawali: Two Different Paradigms of the Harappan Urbis Forma, Puratattva (1999) 29: 14-37.

118. Bisht, R. S., Urban Planning at Dholavira: A Harappan City, In Malville, J. M. and Gujral, L. M. (ed.), Ancient Cities, Sacred Skies: Cosmic Geometries and City Planning in Ancient India (2000) Aryan Books International, New Delhi.

119. Boivin, N., Fuller, D., Korisettar, R. and Petraglia, M., First Farmers in South India: The Role of Internal Processes and External Influences in the Emergence and

Transformation of South India’s Earliest Settled Societies, Pragdhara, **18**, May 2008, 179-199.

120. Chandran, T. V., Ritual as Ideology: text and context in Teyyam (2006) Indira Gandhi National Centre for the Arts, New Delhi.
121. Dagens, B. (tr.), Mayamata: An Indian Treatise on Housing, Architecture and Iconography (1995) Sitaram Bhartia Institute of Science and Research, New Delhi.
122. Dinesan, V., Contextualizing Teyyattam: a perspective, The Journal of the Centre for Heritage Studies, Vol. 2 (2005), 6-14.
123. Fergusson, J., History of Indian and Eastern Architecture: Vol. I and II (1910) Low Price Publications, Delhi.
124. Habib, I., Prehistory (2001) Aligarh Historians Society, Aligarh.
125. Habib, I., The Indus Civilisation: Including Other Copper Age Cultures and History of Language Change till c. 1500 BC (2002) Aligarh Historians Society, Aligarh.
126. Hawkes, J. and Hawkes, C., Prehistoric Britain (1943) Penguin Books, Middlesex.
127. Hodder, I., Architecture and Meaning: The Example of Neolithic Houses and Tombs, in Pearson, M. P. and Richards, C. (ed.), Architecture and Order: Approaches to Social Space (1994) Routledge, London.
128. Johansen, P. G. Landscape, Monumental Architecture and Ritual: A Reconsideration of the South Indian Ashmounds, Journal of Anthropological Archaeology 23 (2004) 309-330.
129. Johnny. O. K., Wayanad Rekhakal (Malayalam) (2001) Olive Publications Pvt. Ltd. Kozhikode.
130. Joshi, J. P., Harappan Architecture and Civil Engineering (2008) Rupa & Co., New Delhi.
131. Jung, C. G. et al, Man and His Symbols (1968) Dell Publishing, USA.
132. Kohler, T. A., Gumerman, G. J. and Reynolds, R. J., Simulating Ancient Societies, Scientific American India (2005), Vol. 1, No. 2.
133. Kennedy, K. A. R., God-Apes and Fossil Men: Palaeoanthropology in South Asia (2000) The University of Mishigan Press, Ann Arbor.
134. Leakey, R., The Origin of Humankind (1994) Orion Books Ltd., London.

135. Lewis-Williams, D., The Mind in the Cave: Consciousness and the Origin of Art (2002) Thames and Hudson, London.
136. Marshall, W. E., A Phrenologist among the Todas (1995) Asian Educational Services, New Delhi.
137. Mithen, S., The Prehistory of the Mind: A Search for the Origins of Art, Religion and Science (1996) Thames and Hudson, London.
138. Menon, A. S., A Survey of Kerala History (1967) D. C. Books, Kottayam.
139. Menon, A. S., Cultural Heritage of Kerala (1978) D. C. Books, Kottayam.
140. Menon, A. S., The Legacy of Kerala (1982) D. C. Books, Kottayam.
141. Oldham, C. F., The Sun and the Serpent: a Contribution to the History of Serpent-worship (1988) Asian Educational Services, New Delhi.
142. Paddayya, K., The Ashmounds of South India: Fresh Evidence and Possible Explanation, Bulletin of the Deccan College Postgraduate Research Institute (1991) Deccan College, Pune.
143. Parthasarathy, J., Todas of the Nilgiri Hills: Anthropological Reflections on Community Survival (2005) Director of Museums, Government of Tamilnadu.
144. Pearson, M. P. and Richards, C., Ordering the World: Perceptions of Architecture, Space and Time, in Pearson, M. P. and Richards, C. (ed.), Architecture and Order: Approaches to Social Space (1994) Routledge, London.
145. Pearson, M. P. and Richards, C., Architecture and Order: Spatial Representation and Archaeology, in Pearson, M. P. and Richards, C. (ed.), Architecture and Order: Approaches to Social Space (1994) Routledge, London.
146. Plunket, E., Calendars and Constellations of the Ancient World (1903) Random House (UK) Ltd., London.
147. Poonacha, K. P., Archaeology of Karnataka: Pre and Proto History of South Western Region (2011) Bharatiya Kala Prakashan, Delhi.
148. Possehl, G. L., The Indus Civilization: a Contemporary Perspective (2002) Vistaar Publications, New Delhi.
149. Rajendran, P., The Prehistoric Cultures and Environment: A Case Study of Kerala (1989) Classical Publishing Company, New Delhi.

150. Ratnagar, S., Understanding Harappa: Civilization in the Greater Indus Valley (2001) Tulika Books, New Delhi.
151. Renfrew, C., Prehistory: The Making of the Human Mind (2007) Phoenix, London.
152. Sharma, A. K., Early Man in Jammu Kashmir and Ladakh (2000) Agam Kala Prakashan, Delhi.
153. Shrimali, K. M., The Age of Iron and the Religious Revolution: c. 700 – c.350 BC (2007) Aligarh Historians Society, Aligarh.
154. Sidharth, B. G., The Celestial Key to the Vedas: Discovering the Origins of the World's Oldest Civilization (1999) Inner Traditions, Rochester.
155. Thapar, R., The Penguin History of Early India: From the Origins to AD 1300 (2002) Penguin Books, New Delhi.
156. Thompson, R. L., The Cosmology of the Bhagavata Purana: Mysteries of the Sacred Universe (2000) Motiyal Banarsidass Publishers Pvt. Ltd., Delhi.
157. Tilak, B., Arctic Home in the Vedas (2005) Vijay Goel, Delhi.
158. Tilak, B., Orion: A Search into the Ancientness of Aryan-Vedic Culture (2005) Vijay Goel, Delhi.
159. Whitehead, H., The Village Gods of South India (1999) Asian Educational Services, New Delhi.
160. Wells, S., The Journey of Man: A Genetic Odyssey (2002), Penguin Books, New Delhi.
161. Wilson, P., The Domestication of the Human Species (1988) Yale University Press, New Haven, Conn.
162. Wong, K., The Morning of the Modern Mind, Scientific American India (2005) Vol. 1, No. 1.

e. Astronomy

163. Burgess. E. (tr.), Gangooly, P. (ed.), The Surya Siddhanta: A Text-book of Hindu Astronomy (1860) Motilal Banarsidass Publishers Pvt. Ltd., Delhi.
164. Meeus, J., Astronomical Algorithms (1991) Willmann-Bell, Inc., Virginia.

165. Ridpath, I., Norton's Star Atlas and Reference Handbook (Epoch 2000.0) (1998) Addison Wesley Longman Ltd. England.
166. Smart, W. M., Textbook on Spherical Astronomy (1977) Cambridge University Press, Cambridge.

f. Hampi

167. Devakunjari, D., Hampi (1992) Archaeological Survey of India, New Delhi.
168. Longhurst, A. H., Hampi Ruins: described and illustrated (1917) Asian Educational Services, New Delhi.
169. Malville. J. M., Cosmic Landscape and Urban Layout, in Fritz, J. M. and Michell, G. (ed.), New Light on Hampi (2001) Marg Publications, Mumbai.
170. Michell, G., The Vijayanagara Courtly Style: incorporation and synthesis in the royal architecture of southern India, 15^{th} – 17^{th} centuries (1992) American Institute of Indian Studies, New Delhi.
171. Paes, D. and Nuniz, F., The Vijayanagar Empire: chronicles of Paes and Nuniz (2003) Asian Educational Services, New Delhi.
172. Rao, M. S. N. (ed.), Vijayanagara: through the eyes of Alexander J. Greenlaw 1856 and John Gollings 1983 (1988) Directorate of Archaeology and Museums, Mysore.
173. Settar, S., Hampi: a medieval metropolis (1990) Kala Yatra, Bangalore.
174. Srinivasachar, S. and Satyan, T. S., Hampi: the fabled capital of the Vijayanagara Empire (1995) Directorate of Archaeology and Museums, Mysore.